STORMWATER DRAINAGE REPORT

Columbus JACK/Regent
Southpark Place
Grove City, Ohio

November 4, 2016

AMERICAN STRUCTUREPOINT INC.

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Registered Engineer **Date**

1.0 Project Description

The proposed project is located on Southpark Place, Franklin County, Grove City, Ohio. The development will consist of a 75,000 sq ft warehouse, loading docks, and parking facilities. The total disturbed acreage for the project is 10.964 acres. The retention basin design accounts for all 10.964 acres, which meets the detention requirements of the *Grove City Stormwater Drainage Manual (GCSDM)*

The 10.964 acres of property to be disturbed currently consists of farmed fields, trees, and maintained grass. The existing mounding along the western portion of the property will remain.

An aerial map can be found in Appendix A and a soils map can be found in Appendix B of this report.

2.0 Pre-Developed Drainage

Currently, the 10.964 acres disturbed with this project sheet flows from the property to an existing 24" pipe that exits the east side of the site. The drainage ultimately drains to an unnamed tributary stream of the Scioto River. The pre-developed tributary area consists of farmed fields, trees, and maintained grass, which results in a weighted CN of 81 and a time of concentration (TC) of 24.8 minutes.

Per FEMA FIRM Map Number 39049CV0318K, dated June, 18, 2008, the entire property is located in Zone X, an area determined to be outside of the 0.2% annual chance floodplain. These FEMA FIRM Panel can be found in Appendix C.

NOAA Rainfall Data can be found in Appendix D, a pre-developed tributary area map can be found in Appendix E and pre-developed runoff calculations using HydroCAD Version 10.00 by HydroCAD Software Solutions, LLC can be found in Appendix F of this report.

3.0 Post-Developed Drainage

The post-developed drainage for the 10.964 acres disturbed will outlet into an existing curb inlet located in Southpark Place. The post-developed disturbed area consist of the 75,000 sq ft warehouse, loading docks, parking, walks, and basin, which results in a weighted CN of 90 and a time of concentration (TC) of 13.4 minutes.

A post-developed tributary area map can be found in Appendix G and post-developed runoff calculations using HydroCAD Version 10.00 by HydroCAD Software Solutions, LLC can be found in Appendix H of this report.

3.1 Critical Storm

Per Table 3:1 of the *GCSDM*, the critical storm event was calculated by comparing the pre-developed and post-developed 1-year, 24-hour event using the SCS Type II distribution curve. See figure 3.1.1 below:

Figure 3.1.1 Pre-Developed vs. Post-Developed 1-year, 24-hour Storm Event

Pre-Developed 1-year, 24-hour (af)	Post-Developed 1-year, 24 hour (af)
0.666	1.153

[(1-year Post-Developed) – (1-year Pre-Developed)]/[1-year Pre-Developed] x 100% = % Increase

[1.153 af – 0.666af]/[0.666af] x 100% = 73.12**% Increase (10-year storm event)**

3.2 Allowable Release Rates & Detention

Per the *GCSDM*, a 73.12% increase in runoff assigns the critical storm as the **10-year storm event**. Additionally, the peak runoff rate for storm events larger than the 10-year storm event will be released at the pre-developed rate for the corresponding year storm event.

Site detention and water quality will be provided by a wet detention basin. As previously mentioned, the storm system outlets into an existing catch basin through a 15" pipe.

A stormwater management summary, including allowable release rates for the project are shown below in figure 3.2.1:

Figure 3.2.1 Post-Developed Stormwater Management Summary

Storm Event	Pre-Developed Area Release Rates (cfs)	Allowable Release Rates (cfs)	Post-Developed Release Rates (cfs)	Detention Release Rates (cfs)	Detention Elevation (feet)
1-Year	7.42	7.42	18.78	1.97	781.28
2-Year	10.77	7.42	24.29	3.67	781.56
5-Year	15.88	7.42	32.20	6.16	781.95
10-Year	**20.29**	**7.42**	**38.72**	**6.89**	**782.32**
25-Year	26.68	26.68	47.83	7.79	782.85
50-Year	32.09	32.09	55.36	8.45	783.27
100-Year	37.95	37.95	63.38	9.06	783.69

***Denotes Critical Storm**

Figure 3.3.1 Post-Developed Stormwater Storage Summary

Storm Event (Year)	Volume Required (ac-ft)	Volume Provided (ac-ft)
1	0.146	0.623
2	0.203	0.773
5	0.286	0.994
10	0.352	1.216
25	0.233	1.544
50	0.256	1.820
100	0.280	2.113

3.3 Water Quality

Water quality drawdown per the Ohio EPA NPDES Permit No.: OHC000004 for *large construction activities* has been provided in the proposed retention basin for the entire 10.964 acre tributary area. Per Table 2 of the permit, "Wet Extended Detention Basins" shall provide a drain time of 24-hours. Additionally, the Extended Detention Volume EDv for a "Wet Extended Detention Basin" is to be sized at 75% of the Water Quality Volume (WQv) and the first half of the EDv shall not be released in one-third the drain time. Based on this, the EDv for the proposed basin is 0.411 acre-feet at an elevation of 780.87.

A 4" water quality orifice at elevation 780.00 in the proposed Retention Basin, and has been designed to provide drawdown exceeding 24-hours. Water quality volume calculations can be found in Appendix I of this report.

3.4 Storm Sewer (to be included in with Final Engineering Submittal)

An onsite storm sewer system designed for the 2-year design storm and 5-year check storm will be installed to convey stormwater for the development to the three grated storm structures. All rainfall events, including the 100-year event, are able to be handled by the proposed stormwater system. Routing calculations can be found in Appendix J of this report. In some instances storm sewer is designed to meet the existing conditions of the connection points.

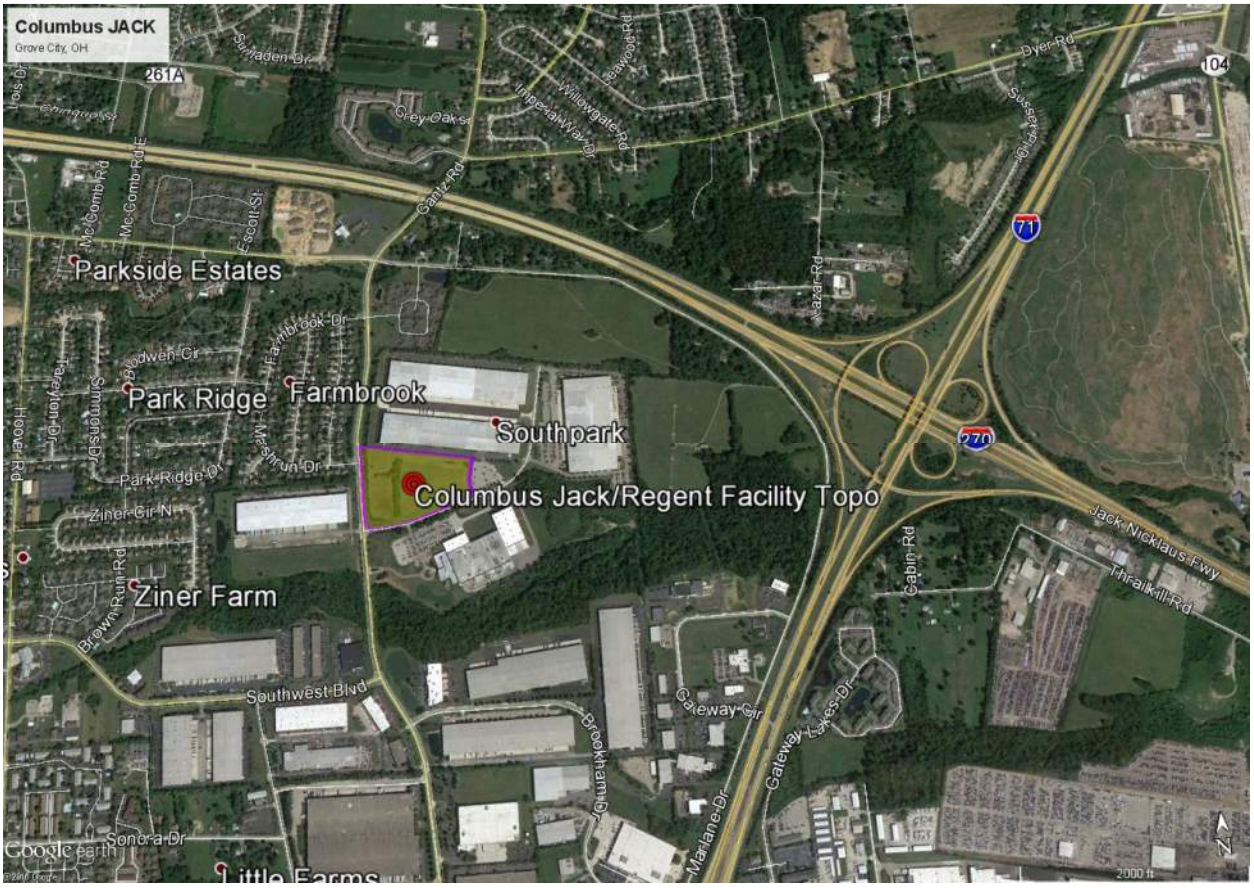
4.0 Summary and Conclusions

The development of this property meets or exceeds Ohio EPA water quality requirements for "large construction activities" and detention requirements per the *GCSDM.*

Accordingly, we believe the proposed improvements will not adversely affect this site, adjacent property owners or Grove City.

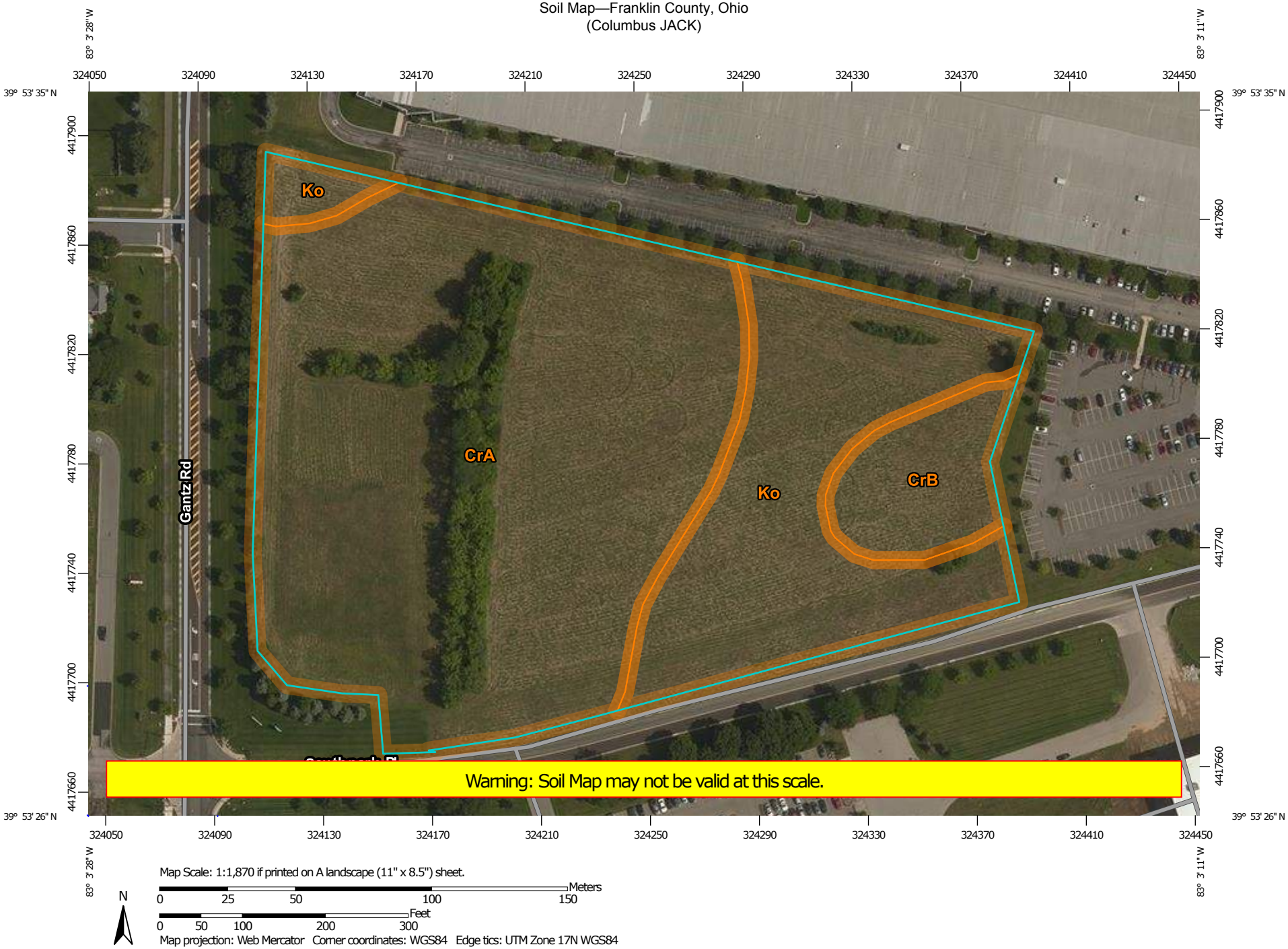
Appendix A - Project Location Map

Project Location Map



Appendix B – Soils Data

Soil Map—Franklin County, Ohio
(Columbus JACK)



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Franklin County, Ohio
Survey Area Data: Version 13, Sep 26, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 4, 2014—Aug 27, 2014

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Franklin County, Ohio (OH049)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
CrA	Crosby silt loam, Southern Ohio Till Plain, 0 to 2 percent slopes	7.4	65.6%
CrB	Crosby silt loam, Southern Ohio Till Plain, 2 to 6 percent slopes	0.8	6.9%
Ko	Kokomo silty clay loam, 0 to 2 percent slopes	3.1	27.5%
Totals for Area of Interest		**11.2**	**100.0%**

Franklin County, Ohio

CrA—Crosby silt loam, Southern Ohio Till Plain, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2thy7
Elevation: 520 to 1,550 feet
Mean annual precipitation: 36 to 44 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 145 to 180 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Crosby and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Crosby

Setting

Landform: Ground moraines, recessionial moraines, water-lain moraines
Landform position (two-dimensional): Summit, backslope, footslope
Landform position (three-dimensional): Interfluve, rise
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Silty material or loess over loamy till

Typical profile

Ap - 0 to 8 inches: silt loam
BE - 8 to 11 inches: silt loam
Bt1 - 11 to 14 inches: silt loam
2Bt2 - 14 to 28 inches: silty clay loam
2BCt - 28 to 36 inches: loam
2Cd - 36 to 79 inches: loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: 24 to 40 inches to densic material
Natural drainage class: Somewhat poorly drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately high (0.01 to 0.20 in/hr)
Depth to water table: About 6 to 24 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 50 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 5.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C/D
Hydric soil rating: No

Minor Components

Kokomo, drained

Percent of map unit: 5 percent
Landform: Depressions, swales, water-lain moraines
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Base slope, dip
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: Yes

Celina, eroded

Percent of map unit: 4 percent
Landform: Ground moraines, recessionial moraines, water-lain moraines
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, crest, head slope, nose slope, rise
Down-slope shape: Convex, linear
Across-slope shape: Linear, convex
Hydric soil rating: No

Miamian, eroded

Percent of map unit: 1 percent
Landform: Ground moraines, recessionial moraines, water-lain moraines
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Crest, head slope, nose slope, side slope, rise
Down-slope shape: Convex, linear
Across-slope shape: Linear, convex
Hydric soil rating: No

Data Source Information

Soil Survey Area: Franklin County, Ohio
Survey Area Data: Version 13, Sep 26, 2015

Franklin County, Ohio

CrB—Crosby silt loam, Southern Ohio Till Plain, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 2thy8
Elevation: 520 to 1,550 feet
Mean annual precipitation: 36 to 44 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 145 to 180 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Crosby and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Crosby

Setting

Landform: Ground moraines, recessionial moraines, water-lain moraines
Landform position (two-dimensional): Summit, backslope, footslope
Landform position (three-dimensional): Interfluve, rise
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Silty material or loess over loamy till

Typical profile

Ap - 0 to 8 inches: silt loam
BE - 8 to 11 inches: silt loam
Bt1 - 11 to 14 inches: silt loam
2Bt2 - 14 to 28 inches: silty clay loam
2BCt - 28 to 36 inches: loam
2Cd - 36 to 79 inches: loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: 24 to 40 inches to densic material
Natural drainage class: Somewhat poorly drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately high (0.01 to 0.20 in/hr)
Depth to water table: About 6 to 24 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 50 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 5.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C/D
Hydric soil rating: No

Minor Components

Kokomo, drained

Percent of map unit: 5 percent
Landform: Depressions, swales, water-lain moraines
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Base slope, dip
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: Yes

Celina, eroded

Percent of map unit: 3 percent
Landform: Ground moraines, recessionial moraines, water-lain moraines
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Crest, head slope, nose slope, side slope, rise
Down-slope shape: Convex, linear
Across-slope shape: Linear, convex
Hydric soil rating: No

Miamian, eroded

Percent of map unit: 1 percent
Landform: Ground moraines, recessionial moraines, water-lain moraines
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Crest, head slope, nose slope, side slope, rise
Down-slope shape: Convex, linear
Across-slope shape: Linear, convex
Hydric soil rating: No

Lewisburg

Percent of map unit: 1 percent
Landform: Ground moraines, recessionial moraines, water-lain moraines
Landform position (two-dimensional): Summit, backslope, footslope
Landform position (three-dimensional): Interfluve, rise
Down-slope shape: Convex
Across-slope shape: Linear

Hydric soil rating: No

Data Source Information

Soil Survey Area: Franklin County, Ohio
Survey Area Data: Version 13, Sep 26, 2015

Franklin County, Ohio

Ko—Kokomo silty clay loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2rwj8
Elevation: 820 to 1,140 feet
Mean annual precipitation: 37 to 46 inches
Mean annual air temperature: 48 to 55 degrees F
Frost-free period: 145 to 180 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Kokomo and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kokomo

Setting

Landform: Depressions on till plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Loamy glaciofluvial deposits derived from sedimentary rock over loamy till derived from limestone and dolomite

Typical profile

Ap - 0 to 11 inches: silty clay loam
Btg - 11 to 41 inches: clay loam
Bt - 41 to 64 inches: clay loam
2C - 64 to 79 inches: loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum in profile: 35 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C/D
Hydric soil rating: Yes

Minor Components

Crosby

Percent of map unit: 5 percent
Landform: Till plains
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Celina

Percent of map unit: 5 percent
Landform: Till plains
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Rise
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Data Source Information

Soil Survey Area: Franklin County, Ohio
Survey Area Data: Version 13, Sep 26, 2015

Appendix C – FEMA FIRM 39049C0318K

MAP SCALE 1 " = 500 '

250 0 500 1000 FEET

NFIP

PANEL 0318K

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

FRANKLIN COUNTY, OHIO

AND INCORPORATED AREAS

PANEL 318 OF 465

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLUMBUS, CITY OF	390170	0318	K
FRANKLIN COUNTY	390167	0318	K
GROVE CITY, CITY OF	390173	0318	K

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
39049C0318K

MAP REVISED
JUNE 17, 2008

Federal Emergency Management Agency

Appendix D – NOAA Rainfall Data

NOAA Atlas 14, Volume 2, Version 3
Location name: Grove City, Ohio, USA*
Latitude: 39.8915°, Longitude: -83.0555°
Elevation: 786.98 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.354** (0.319–0.394)	**0.422** (0.381–0.469)	**0.506** (0.456–0.561)	**0.572** (0.514–0.631)	**0.656** (0.586–0.724)	**0.721** (0.642–0.795)	**0.785** (0.696–0.864)	**0.851** (0.749–0.937)	**0.941** (0.821–1.04)	**1.01** (0.871–1.11)
10-min	**0.550** (0.496–0.612)	**0.659** (0.595–0.732)	**0.787** (0.709–0.871)	**0.883** (0.794–0.974)	**1.00** (0.897–1.11)	**1.09** (0.973–1.21)	**1.18** (1.05–1.30)	**1.27** (1.12–1.40)	**1.38** (1.21–1.52)	**1.47** (1.27–1.61)
15-min	**0.675** (0.608–0.750)	**0.806** (0.727–0.895)	**0.966** (0.870–1.07)	**1.09** (0.977–1.20)	**1.24** (1.11–1.37)	**1.35** (1.20–1.49)	**1.47** (1.30–1.62)	**1.58** (1.39–1.74)	**1.73** (1.51–1.90)	**1.83** (1.59–2.01)
30-min	**0.893** (0.804–0.992)	**1.08** (0.973–1.20)	**1.32** (1.19–1.47)	**1.51** (1.36–1.67)	**1.75** (1.56–1.93)	**1.94** (1.72–2.13)	**2.12** (1.88–2.33)	**2.31** (2.03–2.54)	**2.56** (2.23–2.81)	**2.75** (2.38–3.02)
60-min	**1.09** (0.982–1.21)	**1.32** (1.19–1.47)	**1.66** (1.50–1.84)	**1.92** (1.73–2.12)	**2.27** (2.03–2.50)	**2.55** (2.27–2.81)	**2.84** (2.51–3.12)	**3.13** (2.76–3.45)	**3.54** (3.09–3.89)	**3.86** (3.34–4.24)
2-hr	**1.27** (1.15–1.41)	**1.54** (1.39–1.70)	**1.93** (1.75–2.13)	**2.24** (2.03–2.47)	**2.68** (2.40–2.94)	**3.03** (2.71–3.33)	**3.40** (3.02–3.73)	**3.79** (3.34–4.15)	**4.34** (3.79–4.75)	**4.78** (4.14–5.23)
3-hr	**1.35** (1.22–1.48)	**1.63** (1.48–1.79)	**2.03** (1.85–2.23)	**2.37** (2.14–2.59)	**2.83** (2.55–3.10)	**3.21** (2.89–3.51)	**3.62** (3.23–3.95)	**4.05** (3.58–4.41)	**4.65** (4.08–5.07)	**5.13** (4.46–5.60)
6-hr	**1.61** (1.46–1.77)	**1.93** (1.76–2.13)	**2.40** (2.18–2.64)	**2.80** (2.53–3.06)	**3.36** (3.03–3.67)	**3.83** (3.43–4.17)	**4.34** (3.86–4.71)	**4.88** (4.30–5.29)	**5.66** (4.93–6.14)	**6.30** (5.44–6.84)
12-hr	**1.88** (1.71–2.08)	**2.26** (2.05–2.50)	**2.80** (2.54–3.09)	**3.25** (2.94–3.58)	**3.90** (3.51–4.29)	**4.45** (3.98–4.87)	**5.03** (4.47–5.51)	**5.66** (4.99–6.18)	**6.58** (5.72–7.18)	**7.33** (6.31–8.01)
24-hr	**2.20** (2.04–2.39)	**2.63** (2.44–2.86)	**3.24** (3.00–3.52)	**3.74** (3.46–4.05)	**4.44** (4.09–4.81)	**5.02** (4.61–5.44)	**5.64** (5.15–6.10)	**6.29** (5.70–6.81)	**7.20** (6.46–7.81)	**7.94** (7.07–8.63)
2-day	**2.55** (2.37–2.75)	**3.05** (2.83–3.29)	**3.72** (3.46–4.01)	**4.28** (3.96–4.61)	**5.05** (4.66–5.44)	**5.68** (5.22–6.13)	**6.34** (5.80–6.84)	**7.02** (6.39–7.60)	**7.98** (7.19–8.66)	**8.75** (7.81–9.53)
3-day	**2.74** (2.55–2.95)	**3.26** (3.04–3.52)	**3.98** (3.70–4.29)	**4.55** (4.22–4.90)	**5.35** (4.95–5.77)	**6.00** (5.53–6.47)	**6.67** (6.11–7.20)	**7.37** (6.72–7.96)	**8.34** (7.53–9.03)	**9.10** (8.16–9.89)
4-day	**2.92** (2.72–3.15)	**3.48** (3.24–3.75)	**4.23** (3.94–4.56)	**4.83** (4.48–5.20)	**5.66** (5.24–6.09)	**6.33** (5.83–6.81)	**7.01** (6.43–7.56)	**7.72** (7.05–8.33)	**8.69** (7.87–9.40)	**9.46** (8.50–10.3)
7-day	**3.49** (3.25–3.76)	**4.16** (3.87–4.47)	**5.03** (4.67–5.40)	**5.73** (5.32–6.16)	**6.72** (6.20–7.21)	**7.51** (6.91–8.06)	**8.32** (7.62–8.95)	**9.17** (8.35–9.88)	**10.4** (9.35–11.2)	**11.3** (10.1–12.3)
10-day	**3.98** (3.73–4.26)	**4.72** (4.43–5.06)	**5.66** (5.30–6.05)	**6.40** (5.99–6.85)	**7.44** (6.93–7.96)	**8.26** (7.67–8.84)	**9.10** (8.41–9.75)	**9.97** (9.17–10.7)	**11.2** (10.2–12.0)	**12.1** (10.9–13.0)
20-day	**5.53** (5.21–5.87)	**6.53** (6.15–6.93)	**7.68** (7.23–8.15)	**8.58** (8.07–9.10)	**9.78** (9.17–10.4)	**10.7** (10.0–11.4)	**11.6** (10.9–12.4)	**12.5** (11.7–13.3)	**13.7** (12.7–14.7)	**14.6** (13.5–15.7)
30-day	**6.93** (6.55–7.34)	**8.16** (7.71–8.63)	**9.48** (8.95–10.0)	**10.5** (9.89–11.1)	**11.8** (11.1–12.5)	**12.8** (12.0–13.5)	**13.7** (12.9–14.5)	**14.7** (13.7–15.5)	**15.8** (14.7–16.8)	**16.7** (15.5–17.8)
45-day	**8.82** (8.37–9.30)	**10.4** (9.82–10.9)	**11.9** (11.3–12.5)	**13.1** (12.4–13.8)	**14.5** (13.7–15.3)	**15.6** (14.7–16.4)	**16.6** (15.6–17.5)	**17.6** (16.5–18.6)	**18.7** (17.6–19.9)	**19.6** (18.3–20.8)
60-day	**10.7** (10.1–11.2)	**12.5** (11.8–13.2)	**14.3** (13.5–15.0)	**15.6** (14.7–16.4)	**17.2** (16.3–18.2)	**18.5** (17.4–19.5)	**19.6** (18.4–20.7)	**20.7** (19.4–21.9)	**22.0** (20.6–23.4)	**22.9** (21.4–24.4)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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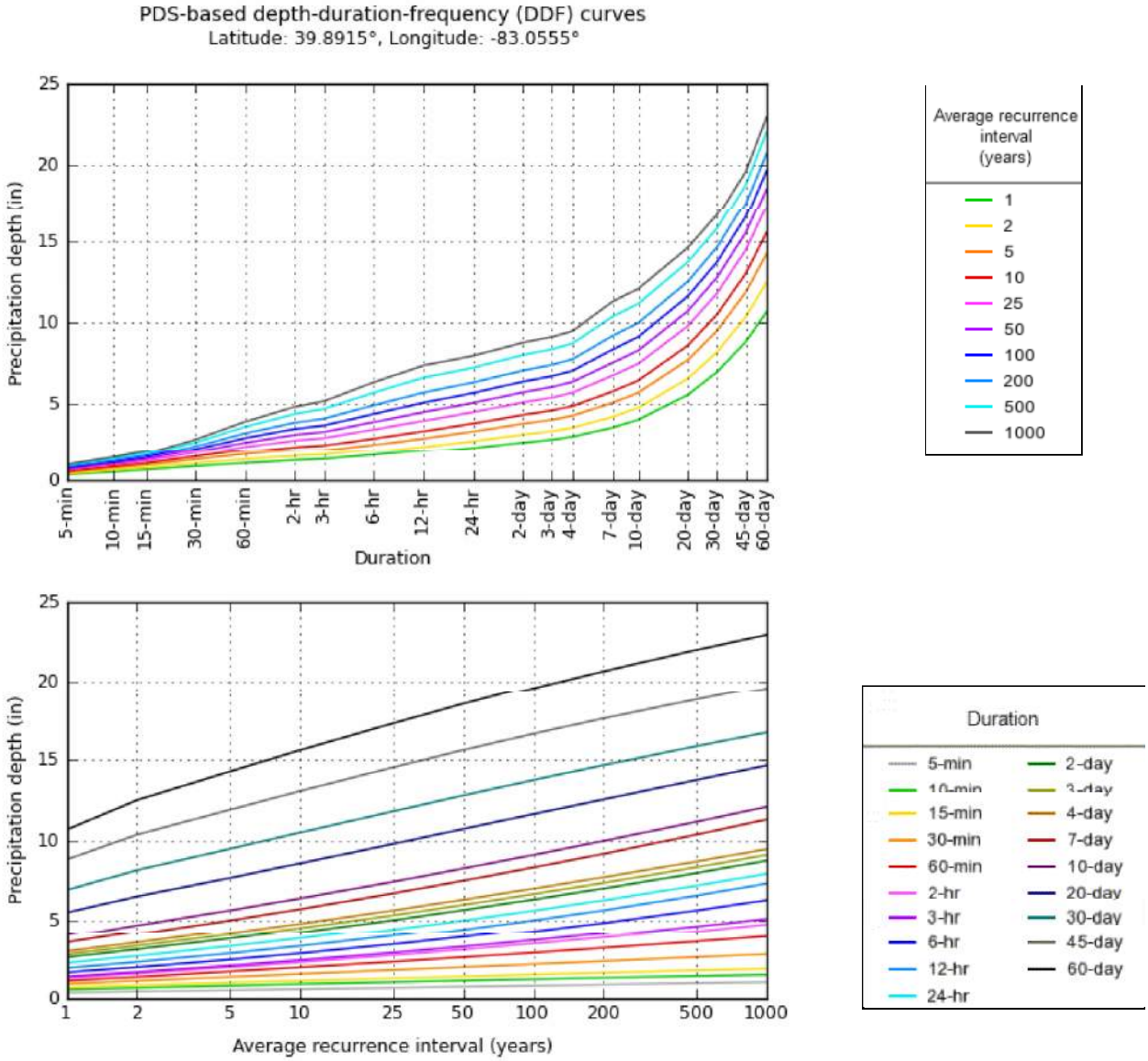
PF graphical



NOAA Atlas 14, Volume 2, Version 3

Created (GMT): Tue Nov 1 16:16:23 2016

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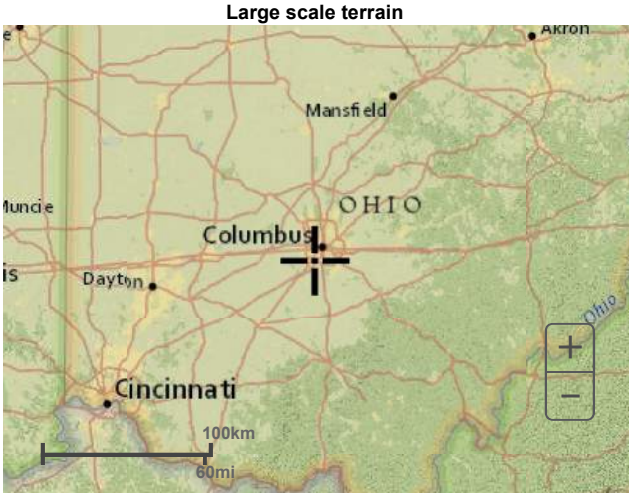
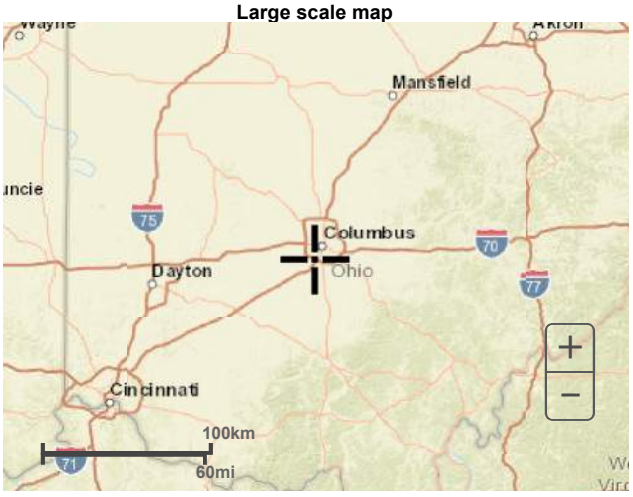
Maps & aerials

Small scale terrain

Large scale terrain



Large scale map



Large scale aerial

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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
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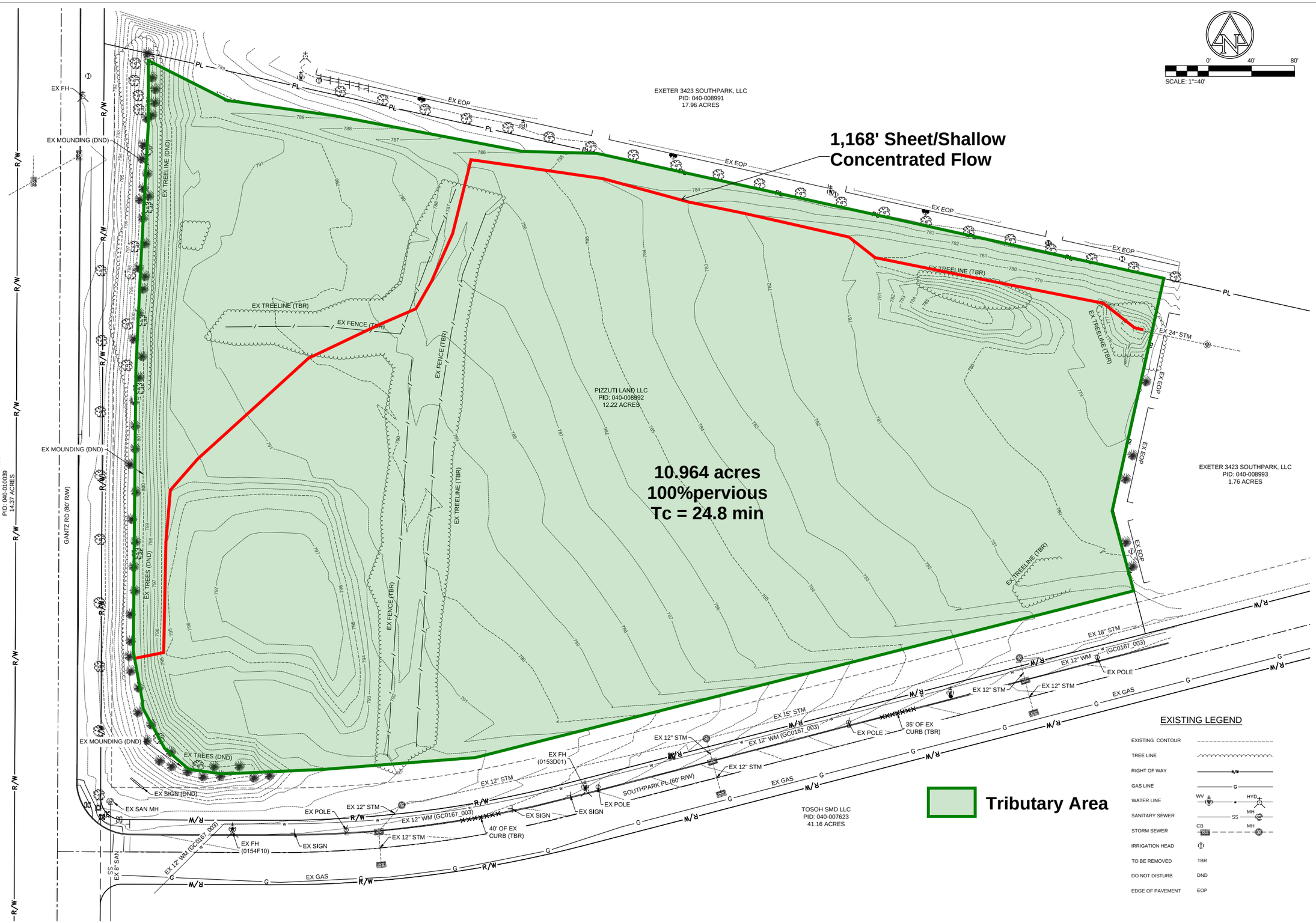
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Appendix E – Pre-Developed Tributary Area Exhibit



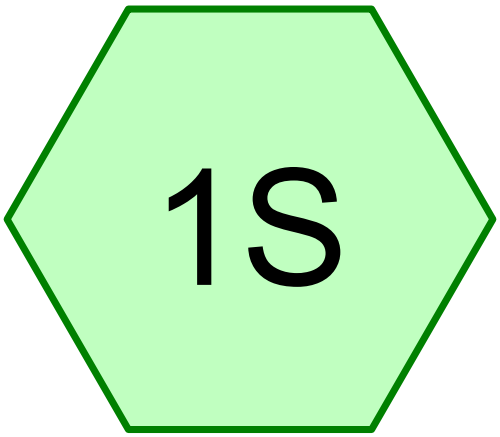
COLUMBUS JACK / REGENT
SOUTH PARK PLACE
GROVE CITY, OHIO 43123
FOR
COLUMBUS JACK / REGENT
2222 SOUTH THIRD STREET | COLUMBUS, OHIO 43207

PROJECT NUMBER: 2016-02315

ISSUE	DATE
ZONING	NOV. 07, 2016

SHEET: Pre

Appendix F – Pre-Developed Runoff Calculations



Pre-Development

Subcat Reach Pond Link

Routing Diagram for 2016.02315.CE.Detention
Prepared by American Structurepoint, Printed 11/4/2016

Summary for Subcatchment 1S: Pre-Development

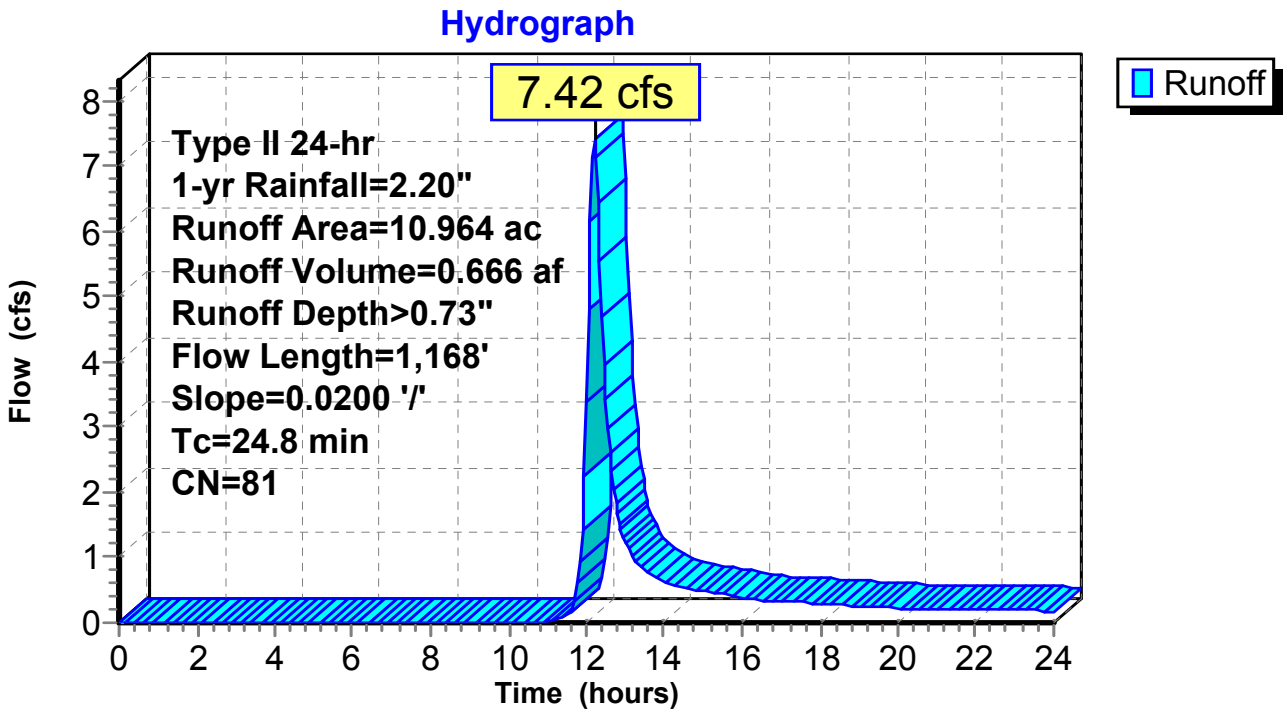
Runoff = 7.42 cfs @ 12.20 hrs, Volume= 0.666 af, Depth> 0.73"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr Rainfall=2.20"

Area (ac)	CN	Description
9.857	82	Row crops, contoured, Good, HSG C
1.107	73	Woods, Fair, HSG C
10.964	81	Weighted Average
10.964		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	100	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.63"
14.0	1,068	0.0200	1.27		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
24.8	1,168	Total			

Subcatchment 1S: Pre-Development



Summary for Subcatchment 1S: Pre-Development

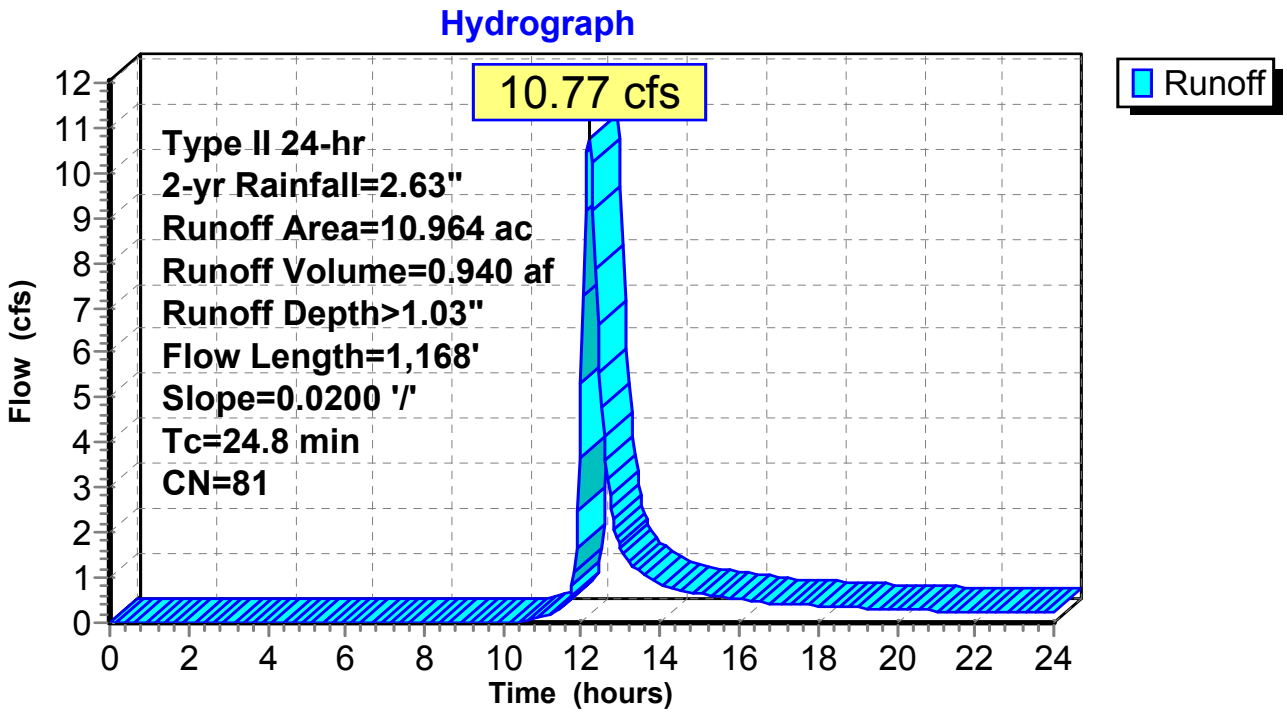
Runoff = 10.77 cfs @ 12.19 hrs, Volume= 0.940 af, Depth> 1.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr Rainfall=2.63"

Area (ac)	CN	Description
9.857	82	Row crops, contoured, Good, HSG C
1.107	73	Woods, Fair, HSG C
10.964	81	Weighted Average
10.964		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	100	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.63"
14.0	1,068	0.0200	1.27		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
24.8	1,168	Total			

Subcatchment 1S: Pre-Development



Summary for Subcatchment 1S: Pre-Development

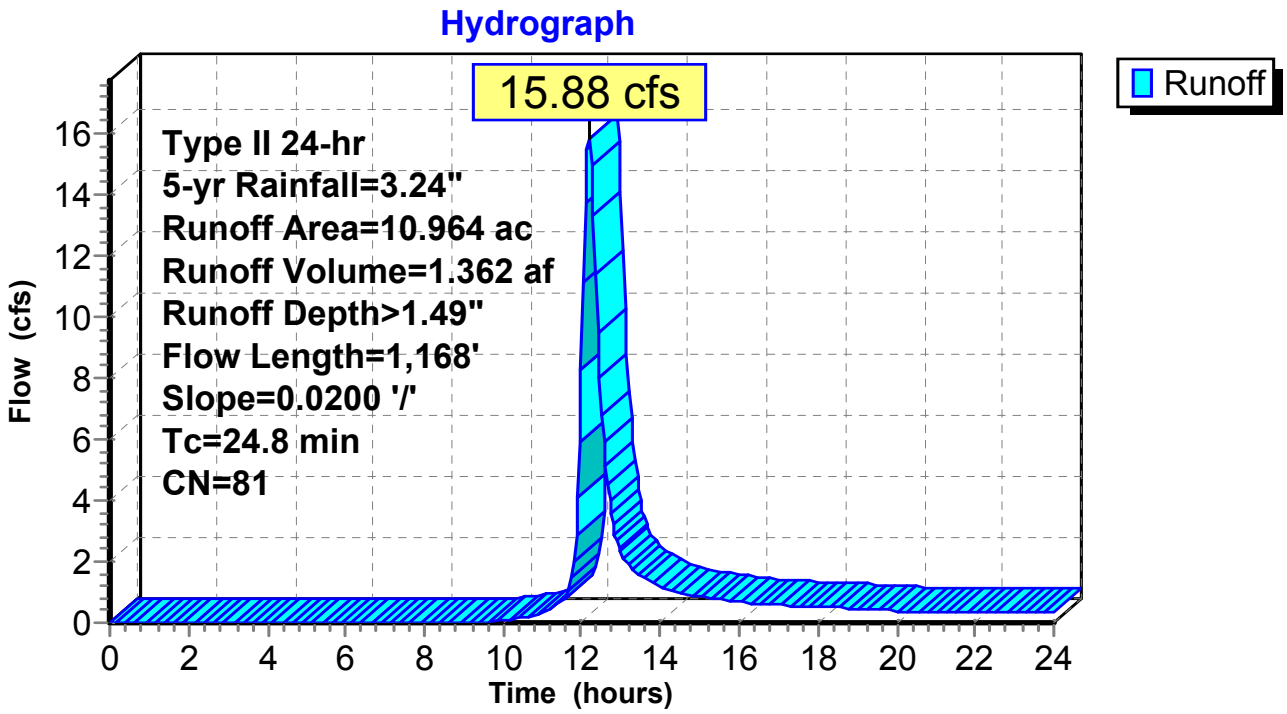
Runoff = 15.88 cfs @ 12.19 hrs, Volume= 1.362 af, Depth> 1.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 5-yr Rainfall=3.24"

Area (ac)	CN	Description
9.857	82	Row crops, contoured, Good, HSG C
1.107	73	Woods, Fair, HSG C
10.964	81	Weighted Average
10.964		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	100	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.63"
14.0	1,068	0.0200	1.27		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
24.8	1,168	Total			

Subcatchment 1S: Pre-Development



Summary for Subcatchment 1S: Pre-Development

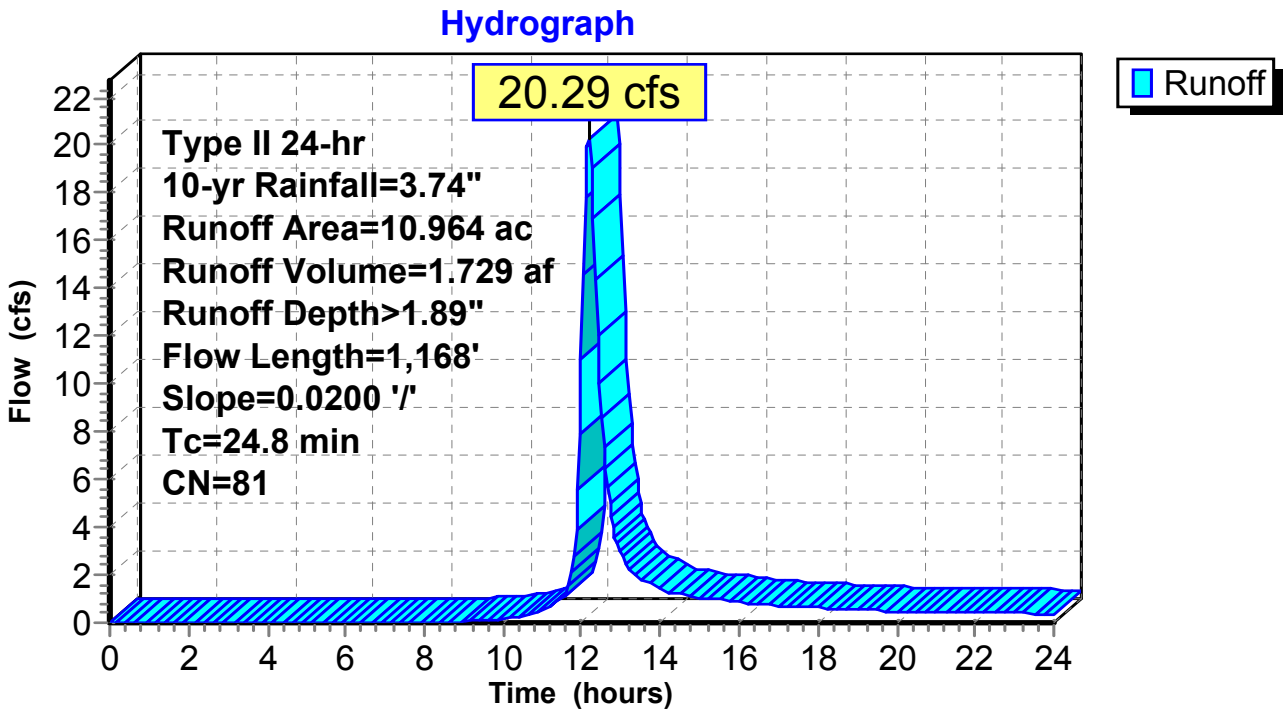
Runoff = 20.29 cfs @ 12.19 hrs, Volume= 1.729 af, Depth> 1.89"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=3.74"

Area (ac)	CN	Description
9.857	82	Row crops, contoured, Good, HSG C
1.107	73	Woods, Fair, HSG C
10.964	81	Weighted Average
10.964		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	100	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.63"
14.0	1,068	0.0200	1.27		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
24.8	1,168	Total			

Subcatchment 1S: Pre-Development



Summary for Subcatchment 1S: Pre-Development

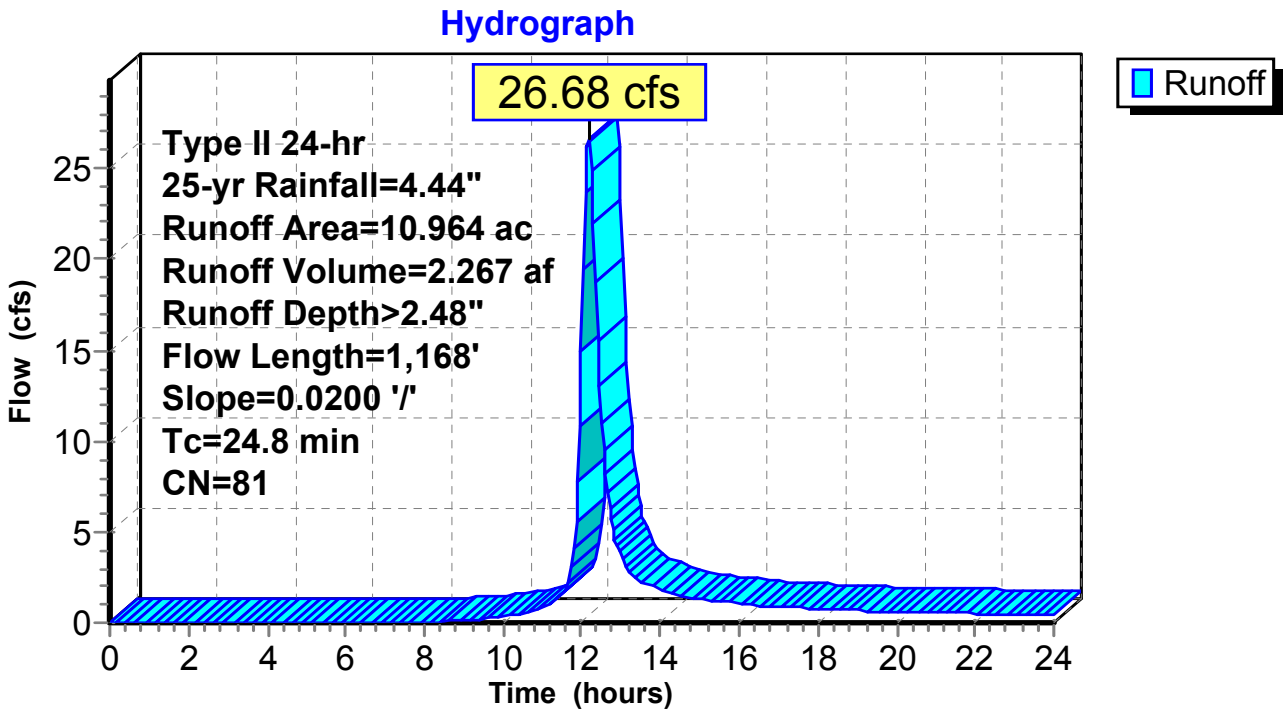
Runoff = 26.68 cfs @ 12.18 hrs, Volume= 2.267 af, Depth> 2.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.44"

Area (ac)	CN	Description
9.857	82	Row crops, contoured, Good, HSG C
1.107	73	Woods, Fair, HSG C
10.964	81	Weighted Average
10.964		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	100	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.63"
14.0	1,068	0.0200	1.27		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
24.8	1,168	Total			

Subcatchment 1S: Pre-Development



Summary for Subcatchment 1S: Pre-Development

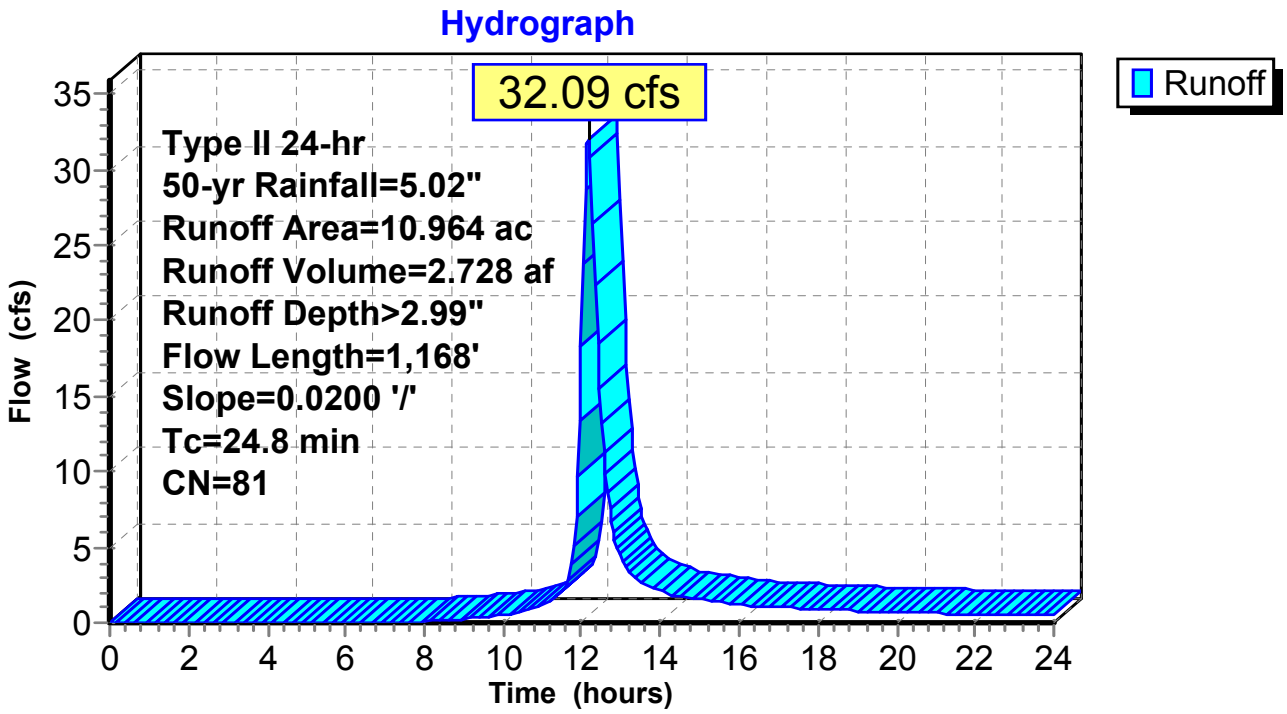
Runoff = 32.09 cfs @ 12.18 hrs, Volume= 2.728 af, Depth> 2.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-yr Rainfall=5.02"

Area (ac)	CN	Description
9.857	82	Row crops, contoured, Good, HSG C
1.107	73	Woods, Fair, HSG C
10.964	81	Weighted Average
10.964		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	100	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.63"
14.0	1,068	0.0200	1.27		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
24.8	1,168	Total			

Subcatchment 1S: Pre-Development



Summary for Subcatchment 1S: Pre-Development

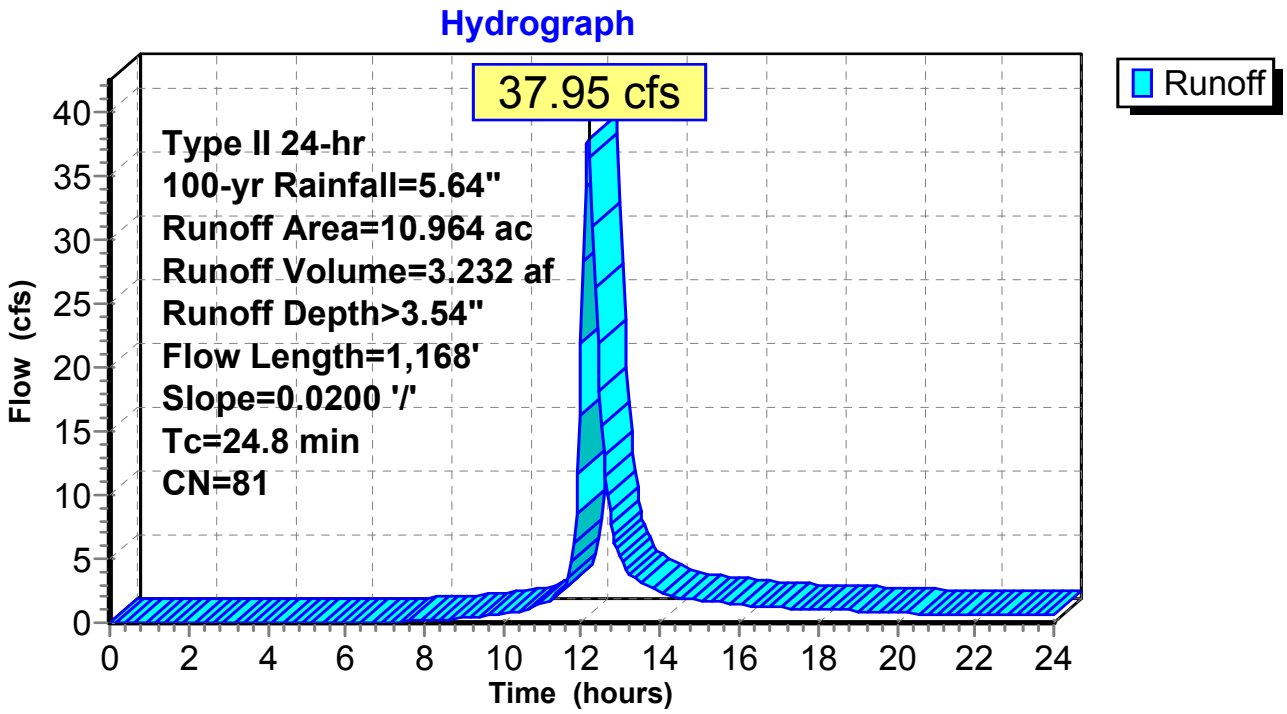
Runoff = 37.95 cfs @ 12.18 hrs, Volume= 3.232 af, Depth> 3.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=5.64"

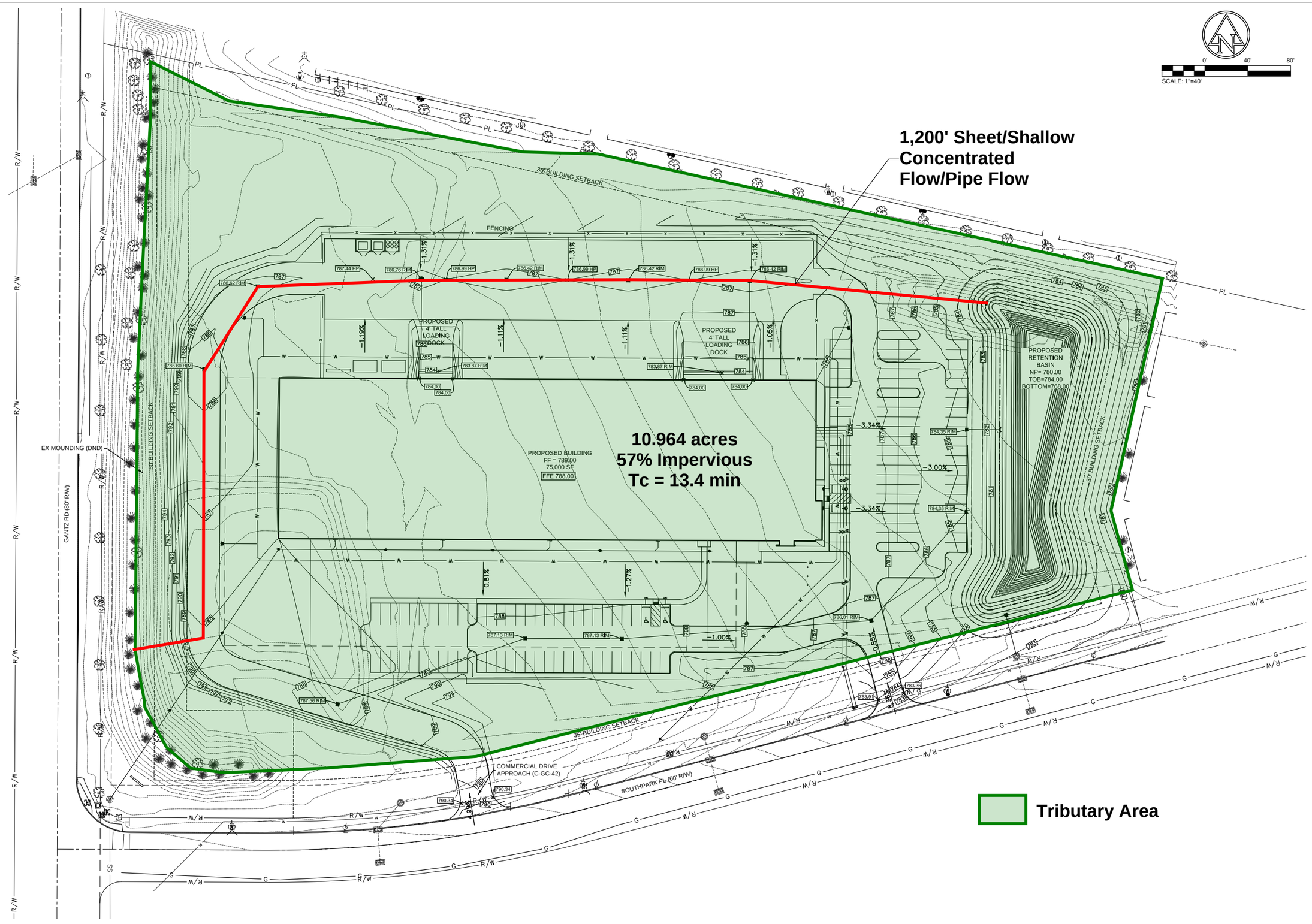
Area (ac)	CN	Description
9.857	82	Row crops, contoured, Good, HSG C
1.107	73	Woods, Fair, HSG C
10.964	81	Weighted Average
10.964		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	100	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.63"
14.0	1,068	0.0200	1.27		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
24.8	1,168	Total			

Subcatchment 1S: Pre-Development



Appendix G – Post-Developed Tributary Area Exhibit



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AMERICAN STRUCTUREPOINT INC.

COLUMBUS JACK / REGENT
SOUTH PARK PLACE
GROVE CITY, OHIO 43123
FOR
COLUMBUS JACK / REGENT
2222 SOUTH THIRD STREET | COLUMBUS, OHIO 43207

PROJECT NUMBER: 2016-02315

ISSUE	DATE
ZONING	NOV. 07, 2016

SHEET: Post

Appendix H – Post-Developed Runoff Calculations Overall

STORM SEWER DESIGN - REQUIRED STORAGE VOLUME - TR55

Project:	**Columbus JACK**
Job #:	**2016.02315**
Location:	**Grove City, OH**
Date:	**11/04/2016**

AMERICAN STRUCTUREPOINT INC.

Page	
1 of 1	
Calc By:	
MJS	
Chk By:	
SLG	

Watershed Area (A) =	10.964	ac	*Total Post-Developed Site Area in Acres*
Runoff Depth (Q) =	2.2	in	*1 yr*
	2.63	in	*2 yr*
	3.24	in	*5 yr*
	3.74	in	*10 yr*
	4.44	in	*25 yr*
	5.02	in	*50 yr*
	5.64	in	*100 yr*

Value of Runoff Depth Taken From HydroCAD in Post Developed Condition

$V_r = QA$

$V_s = V_r(V_s/V_r)$

$q_o = q_i(q_o/q_i)$

V_r = Runoff Volume

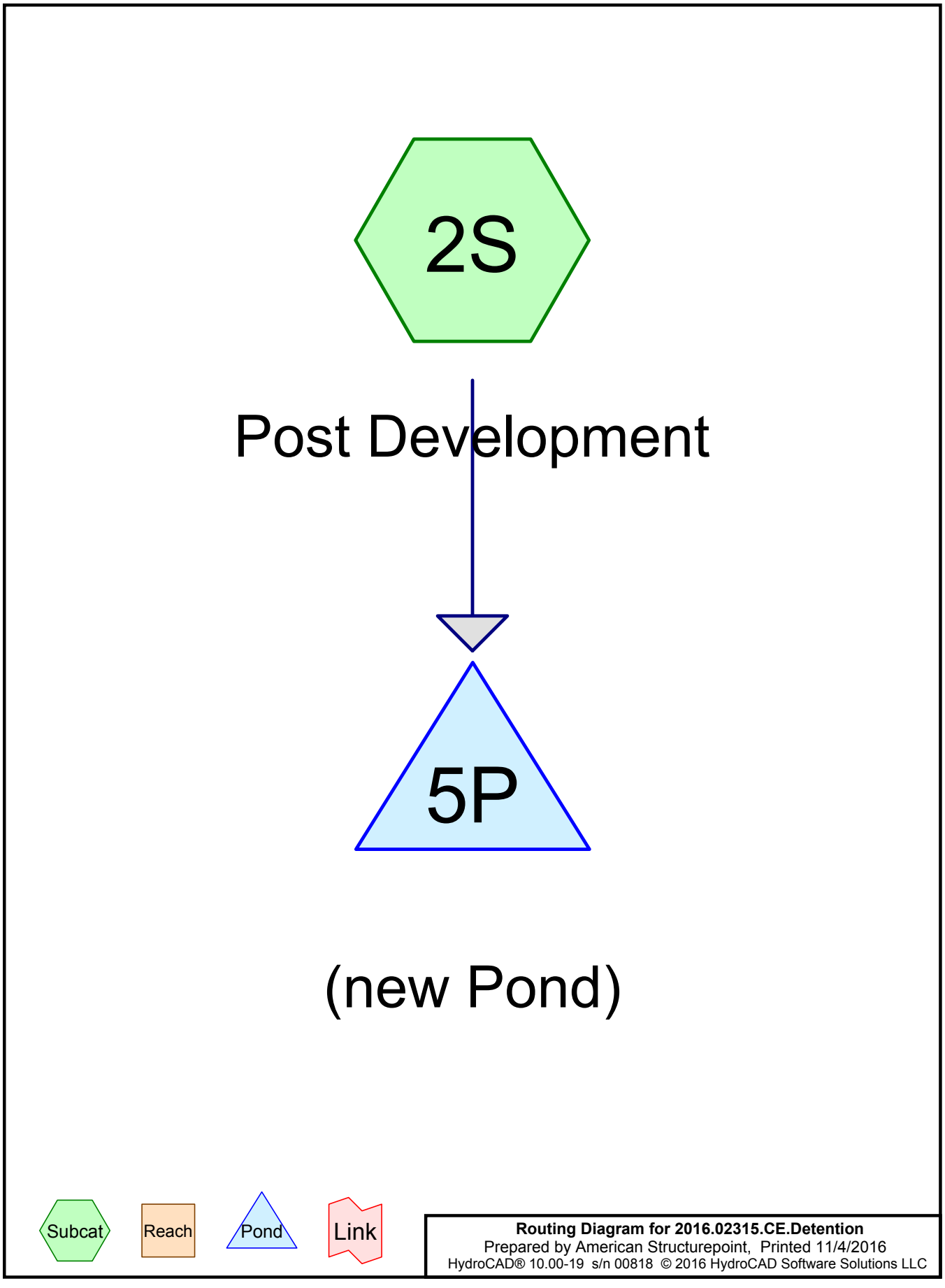
V_s = Storage Volume Required (ac-ft)

V_{sc} = Storage Volume Required (cu-ft)

$$V_s/V_r = C_0 + C_1(q_o/q_i) + C_2(q_o/q_i)^2 + C_3(q_o/q_i)^3$$

C_0 =	0.682	
C_1 =	-1.43	*For Types II and*
C_2 =	1.64	*III Rainfall Distributions*
C_3 =	-0.804	

Event	q_i	q_o	V_s	V_{sc}
1	18.78	7.42	0.1463	6371.76
2	24.29	**7.42**	0.2029	8838.52
5	32.2	7.42	0.2862	12467.91
10	37.72	**7.42**	0.3522	15340.35
25	47.83	26.68	0.2328	10141.71
50	55.36	32.09	0.2555	11127.80
100	63.38	37.95	0.2796	12179.00



Routing Diagram for 2016.02315.CE.Detention
Prepared by American Structurepoint, Printed 11/4/2016

Summary for Subcatchment 2S: Post Development

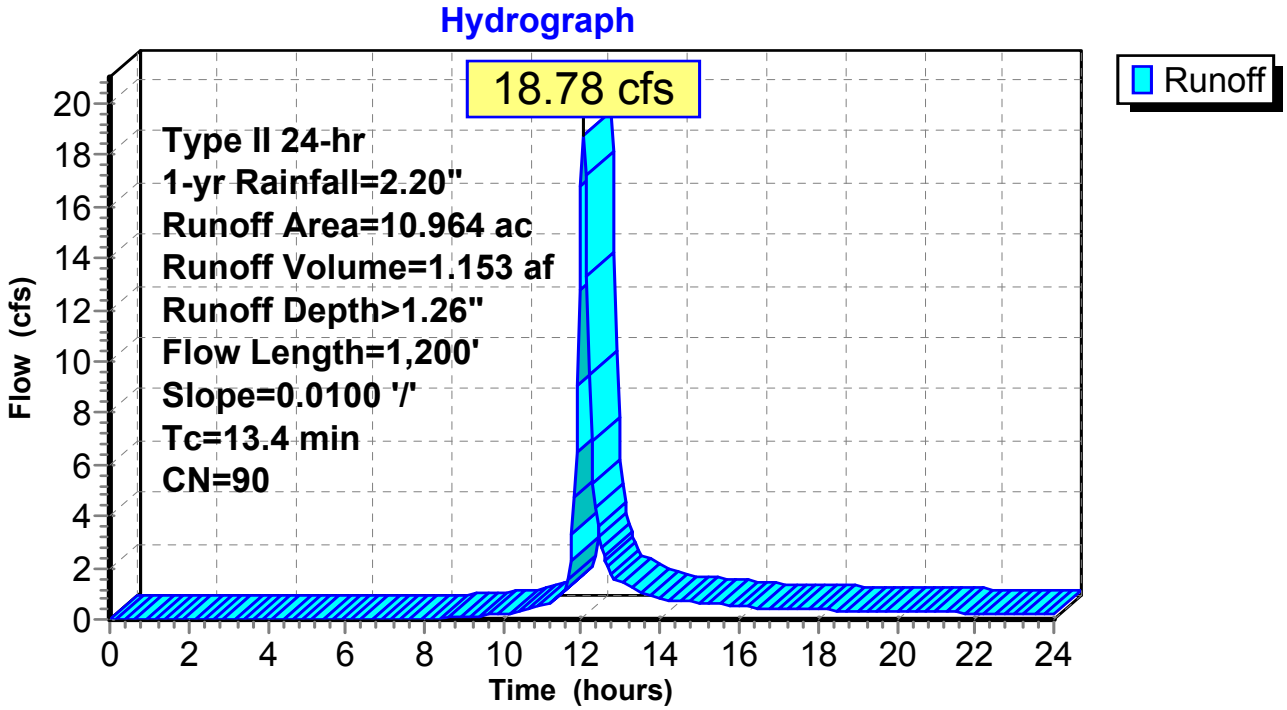
Runoff = 18.78 cfs @ 12.05 hrs, Volume= 1.153 af, Depth> 1.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr Rainfall=2.20"

	Area (ac)	CN	Description
	2.717	80	>75% Grass cover, Good, HSG D
	1.664	80	>75% Grass cover, Good, HSG D
	0.332	80	>75% Grass cover, Good, HSG D
*	6.251	98	Roof, Paved parking, HSG D
	10.964	90	Weighted Average
	4.713		42.99% Pervious Area
	6.251		57.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Pavement Catch Basin**
3.4	1,200	0.0100	5.94	10.50	**Pipe Channel, Pipe Flow** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
13.4	1,200	Total			

Subcatchment 2S: Post Development



Summary for Pond 5P: (new Pond)

Inflow Area = 10.964 ac, 57.01% Impervious, Inflow Depth > 1.26" for 1-yr event
Inflow = 18.78 cfs @ 12.05 hrs, Volume= 1.153 af
Outflow = 1.97 cfs @ 12.67 hrs, Volume= 0.712 af, Atten= 90%, Lag= 36.8 min
Primary = 1.97 cfs @ 12.67 hrs, Volume= 0.712 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 781.28' @ 12.67 hrs Surf.Area= 0.531 ac Storage= 0.623 af

Plug-Flow detention time= 253.0 min calculated for 0.711 af (62% of inflow)
Center-of-Mass det. time= 145.4 min (969.5 - 824.1)

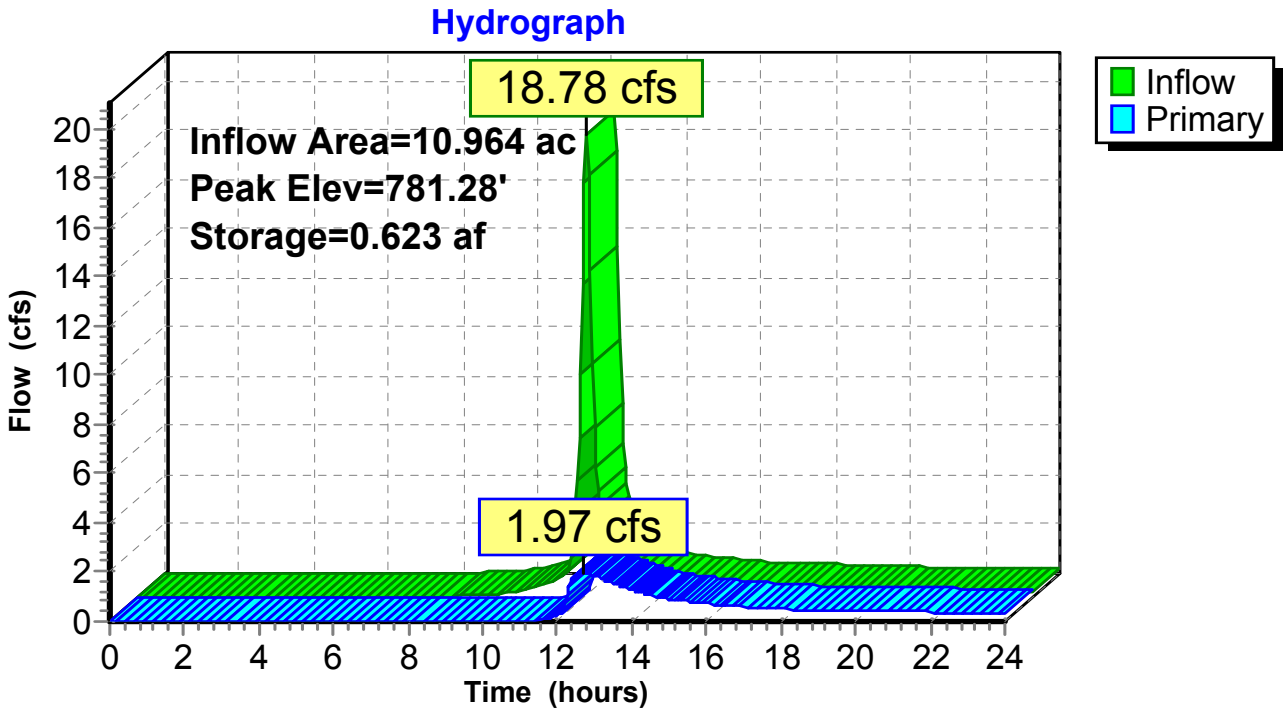
Volume	Invert	Avail.Storage	Storage Description
#1	780.00'	2.333 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
780.00	0.443	0.000	0.000
781.00	0.511	0.477	0.477
782.00	0.582	0.546	1.024
783.00	0.654	0.618	1.641
784.00	0.729	0.692	2.333

Device	Routing	Invert	Outlet Devices
#1	Primary	780.00'	**15.0" Round Culvert** L= 100.0' Ke= 0.500 Inlet / Outlet Invert= 780.00' / 779.20' S= 0.0080 '/' Cc= 0.900 n= 0.013, Flow Area= 1.23 sf
#2	Device 1	780.00'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	781.00'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 1	781.50'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.96 cfs @ 12.67 hrs HW=781.28' (Free Discharge)
└**1=Culvert** (Passes 1.96 cfs of 4.72 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.44 cfs @ 5.08 fps)
  ├**3=Orifice/Grate** (Weir Controls 1.52 cfs @ 1.73 fps)
  └**4=Orifice/Grate** (Controls 0.00 cfs)

Pond 5P: (new Pond)



Summary for Subcatchment 2S: Post Development

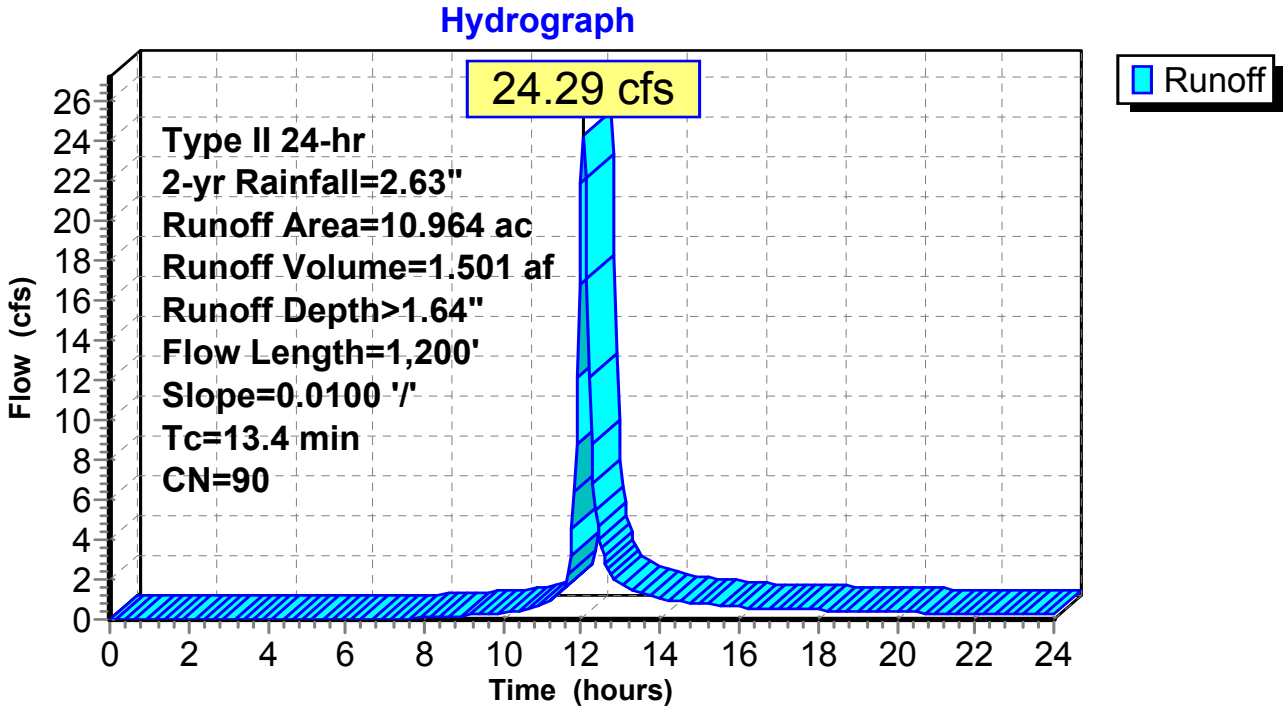
Runoff = 24.29 cfs @ 12.05 hrs, Volume= 1.501 af, Depth> 1.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr Rainfall=2.63"

	Area (ac)	CN	Description
	2.717	80	>75% Grass cover, Good, HSG D
	1.664	80	>75% Grass cover, Good, HSG D
	0.332	80	>75% Grass cover, Good, HSG D
*	6.251	98	Roof, Paved parking, HSG D
	10.964	90	Weighted Average
	4.713		42.99% Pervious Area
	6.251		57.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Pavement Catch Basin**
3.4	1,200	0.0100	5.94	10.50	**Pipe Channel, Pipe Flow** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
13.4	1,200	Total			

Subcatchment 2S: Post Development



Summary for Pond 5P: (new Pond)

Inflow Area = 10.964 ac, 57.01% Impervious, Inflow Depth > 1.64" for 2-yr event
Inflow = 24.29 cfs @ 12.05 hrs, Volume= 1.501 af
Outflow = 3.67 cfs @ 12.49 hrs, Volume= 1.035 af, Atten= 85%, Lag= 26.1 min
Primary = 3.67 cfs @ 12.49 hrs, Volume= 1.035 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 781.56' @ 12.49 hrs Surf.Area= 0.550 ac Storage= 0.773 af

Plug-Flow detention time= 210.5 min calculated for 1.035 af (69% of inflow)
Center-of-Mass det. time= 111.1 min (927.8 - 816.7)

Volume	Invert	Avail.Storage	Storage Description
#1	780.00'	2.333 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

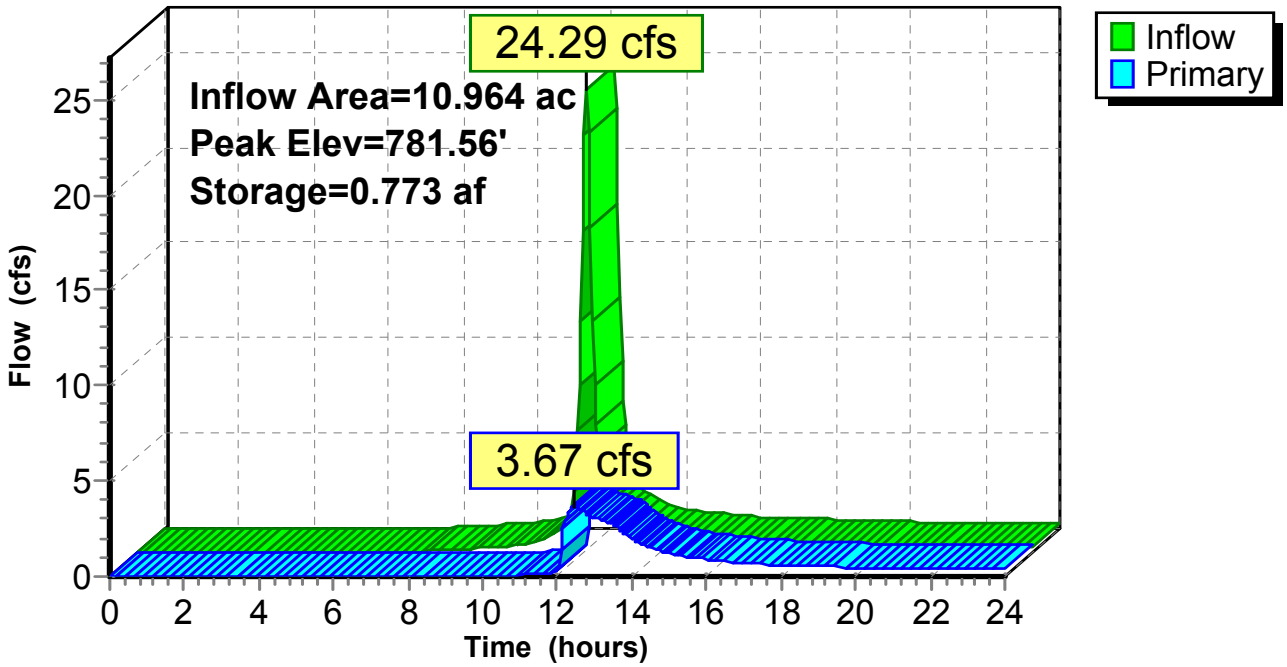
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
780.00	0.443	0.000	0.000
781.00	0.511	0.477	0.477
782.00	0.582	0.546	1.024
783.00	0.654	0.618	1.641
784.00	0.729	0.692	2.333

Device	Routing	Invert	Outlet Devices
#1	Primary	780.00'	**15.0" Round Culvert** L= 100.0' Ke= 0.500 Inlet / Outlet Invert= 780.00' / 779.20' S= 0.0080 '/' Cc= 0.900 n= 0.013, Flow Area= 1.23 sf
#2	Device 1	780.00'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	781.00'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 1	781.50'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=3.67 cfs @ 12.49 hrs HW=781.56' (Free Discharge)
└**1=Culvert** (Passes 3.67 cfs of 5.66 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.50 cfs @ 5.68 fps)
  ├**3=Orifice/Grate** (Orifice Controls 2.82 cfs @ 3.59 fps)
  └**4=Orifice/Grate** (Weir Controls 0.35 cfs @ 0.78 fps)

Pond 5P: (new Pond)

Hydrograph



Summary for Subcatchment 2S: Post Development

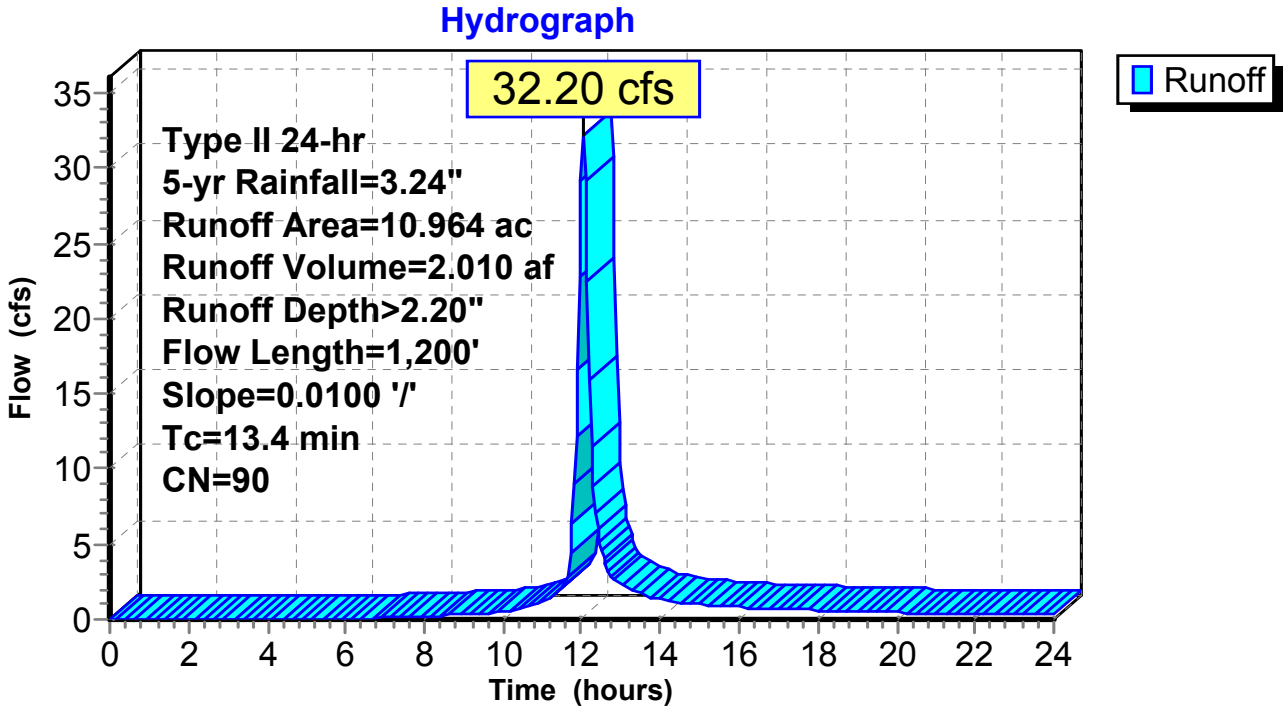
Runoff = 32.20 cfs @ 12.05 hrs, Volume= 2.010 af, Depth> 2.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 5-yr Rainfall=3.24"

	Area (ac)	CN	Description
	2.717	80	>75% Grass cover, Good, HSG D
	1.664	80	>75% Grass cover, Good, HSG D
	0.332	80	>75% Grass cover, Good, HSG D
*	6.251	98	Roof, Paved parking, HSG D
	10.964	90	Weighted Average
	4.713		42.99% Pervious Area
	6.251		57.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Pavement Catch Basin**
3.4	1,200	0.0100	5.94	10.50	**Pipe Channel, Pipe Flow** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
13.4	1,200	Total			

Subcatchment 2S: Post Development



Summary for Pond 5P: (new Pond)

Inflow Area = 10.964 ac, 57.01% Impervious, Inflow Depth > 2.20" for 5-yr event
Inflow = 32.20 cfs @ 12.05 hrs, Volume= 2.010 af
Outflow = 6.16 cfs @ 12.40 hrs, Volume= 1.524 af, Atten= 81%, Lag= 20.8 min
Primary = 6.16 cfs @ 12.40 hrs, Volume= 1.524 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 781.95' @ 12.40 hrs Surf.Area= 0.578 ac Storage= 0.994 af

Plug-Flow detention time= 179.1 min calculated for 1.524 af (76% of inflow)
Center-of-Mass det. time= 91.1 min (899.5 - 808.4)

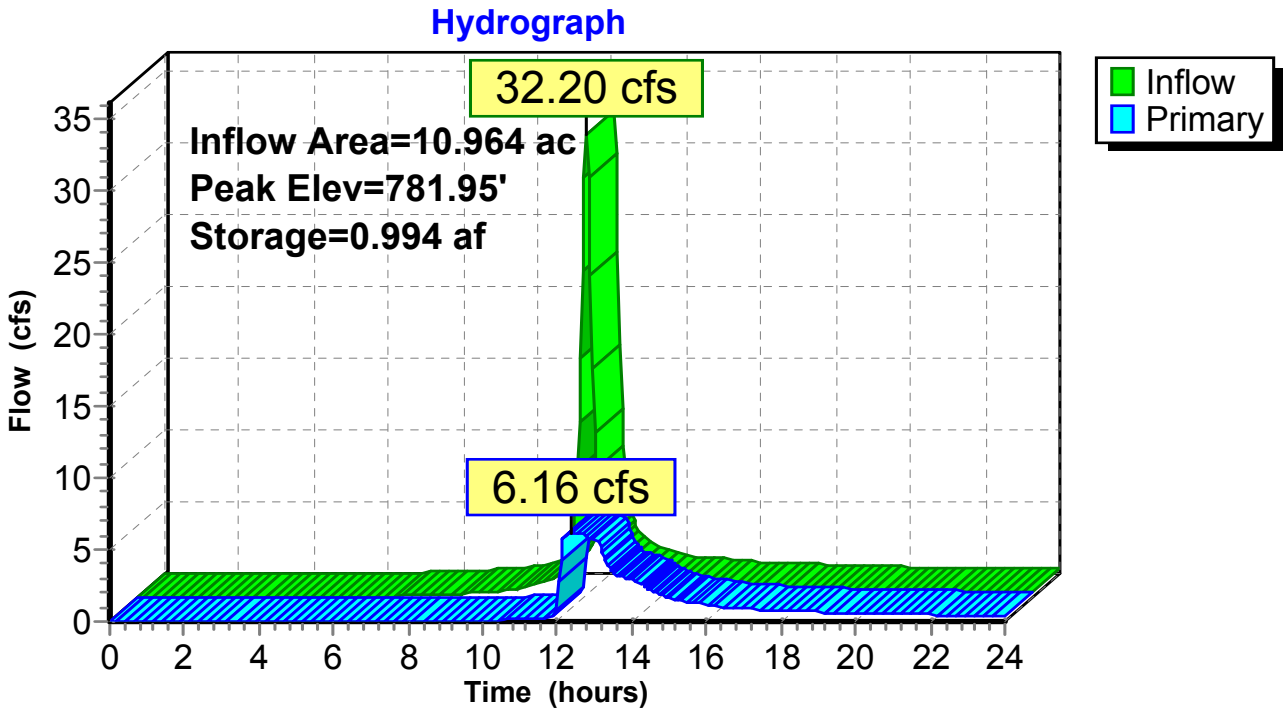
Volume	Invert	Avail.Storage	Storage Description
#1	780.00'	2.333 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
780.00	0.443	0.000	0.000
781.00	0.511	0.477	0.477
782.00	0.582	0.546	1.024
783.00	0.654	0.618	1.641
784.00	0.729	0.692	2.333

Device	Routing	Invert	Outlet Devices
#1	Primary	780.00'	**15.0" Round Culvert** L= 100.0' Ke= 0.500 Inlet / Outlet Invert= 780.00' / 779.20' S= 0.0080 '/' Cc= 0.900 n= 0.013, Flow Area= 1.23 sf
#2	Device 1	780.00'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	781.00'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 1	781.50'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=6.16 cfs @ 12.40 hrs HW=781.95' (Free Discharge)
└**1=Culvert** (Barrel Controls 6.16 cfs @ 5.02 fps)
- **2=Orifice/Grate** (Passes < 0.56 cfs potential flow)
- **3=Orifice/Grate** (Passes < 3.69 cfs potential flow)
- **4=Orifice/Grate** (Passes < 7.89 cfs potential flow)

Pond 5P: (new Pond)



Summary for Subcatchment 2S: Post Development

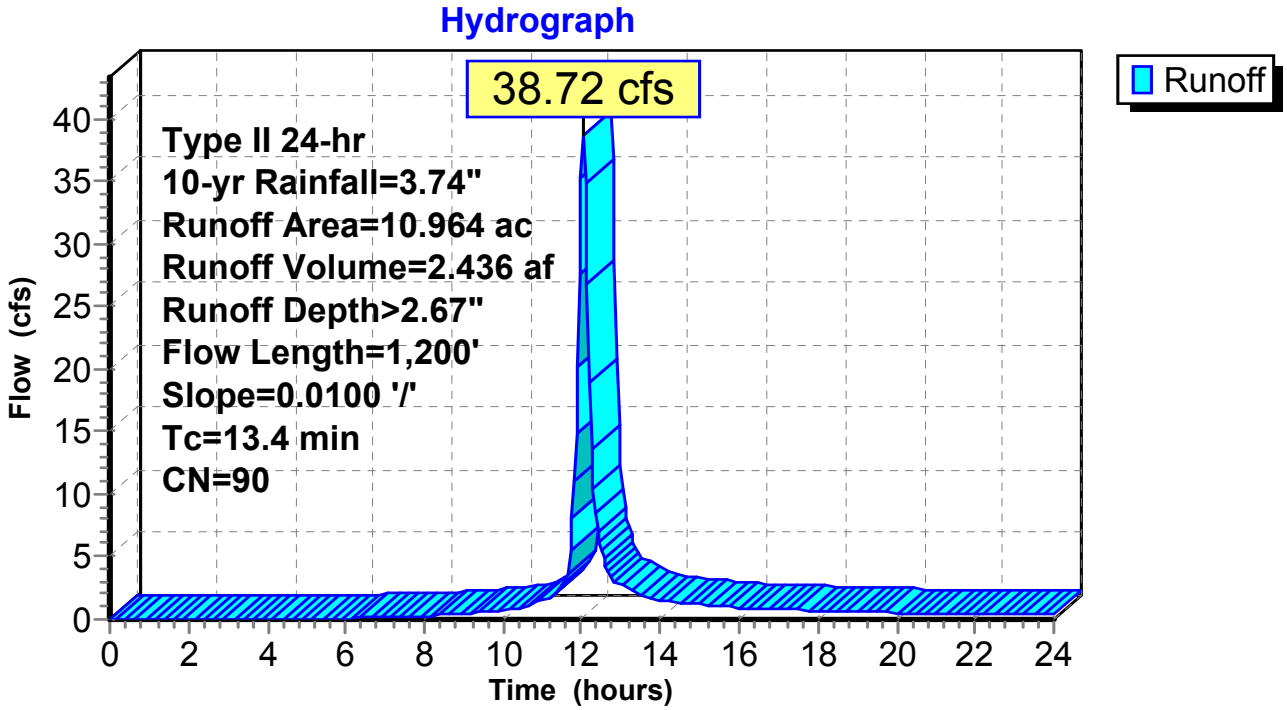
Runoff = 38.72 cfs @ 12.05 hrs, Volume= 2.436 af, Depth> 2.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=3.74"

	Area (ac)	CN	Description
	2.717	80	>75% Grass cover, Good, HSG D
	1.664	80	>75% Grass cover, Good, HSG D
	0.332	80	>75% Grass cover, Good, HSG D
*	6.251	98	Roof, Paved parking, HSG D
	10.964	90	Weighted Average
	4.713		42.99% Pervious Area
	6.251		57.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Pavement Catch Basin**
3.4	1,200	0.0100	5.94	10.50	**Pipe Channel, Pipe Flow** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
13.4	1,200	Total			

Subcatchment 2S: Post Development



Summary for Pond 5P: (new Pond)

Inflow Area = 10.964 ac, 57.01% Impervious, Inflow Depth > 2.67" for 10-yr event
Inflow = 38.72 cfs @ 12.05 hrs, Volume= 2.436 af
Outflow = 6.89 cfs @ 12.41 hrs, Volume= 1.939 af, Atten= 82%, Lag= 21.9 min
Primary = 6.89 cfs @ 12.41 hrs, Volume= 1.939 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 782.32' @ 12.41 hrs Surf.Area= 0.605 ac Storage= 1.216 af

Plug-Flow detention time= 169.1 min calculated for 1.939 af (80% of inflow)
Center-of-Mass det. time= 88.8 min (891.9 - 803.0)

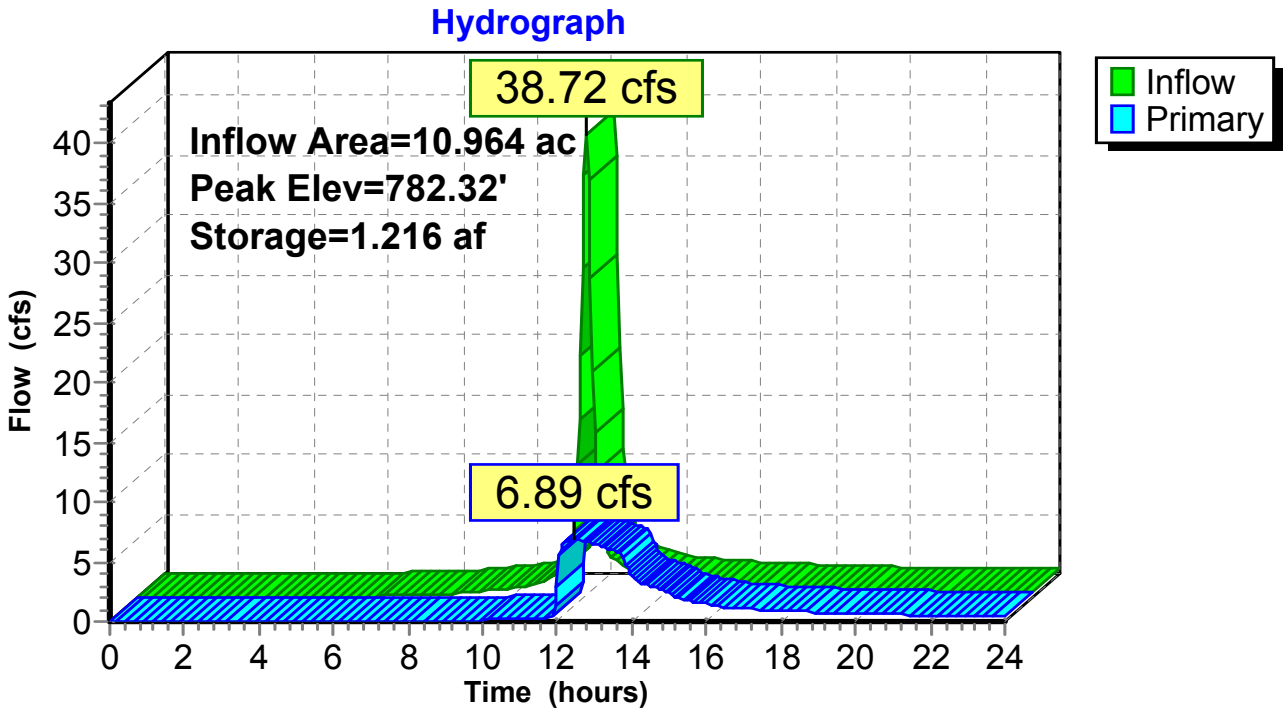
Volume	Invert	Avail.Storage	Storage Description
#1	780.00'	2.333 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
780.00	0.443	0.000	0.000
781.00	0.511	0.477	0.477
782.00	0.582	0.546	1.024
783.00	0.654	0.618	1.641
784.00	0.729	0.692	2.333

Device	Routing	Invert	Outlet Devices
#1	Primary	780.00'	**15.0" Round Culvert** L= 100.0' Ke= 0.500 Inlet / Outlet Invert= 780.00' / 779.20' S= 0.0080 '/' Cc= 0.900 n= 0.013, Flow Area= 1.23 sf
#2	Device 1	780.00'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	781.00'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 1	781.50'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=6.89 cfs @ 12.41 hrs HW=782.32' (Free Discharge)
└**1=Culvert** (Barrel Controls 6.89 cfs @ 5.61 fps)
  ├**2=Orifice/Grate** (Passes < 0.62 cfs potential flow)
  ├**3=Orifice/Grate** (Passes < 4.35 cfs potential flow)
  └**4=Orifice/Grate** (Passes < 17.47 cfs potential flow)

Pond 5P: (new Pond)



Summary for Subcatchment 2S: Post Development

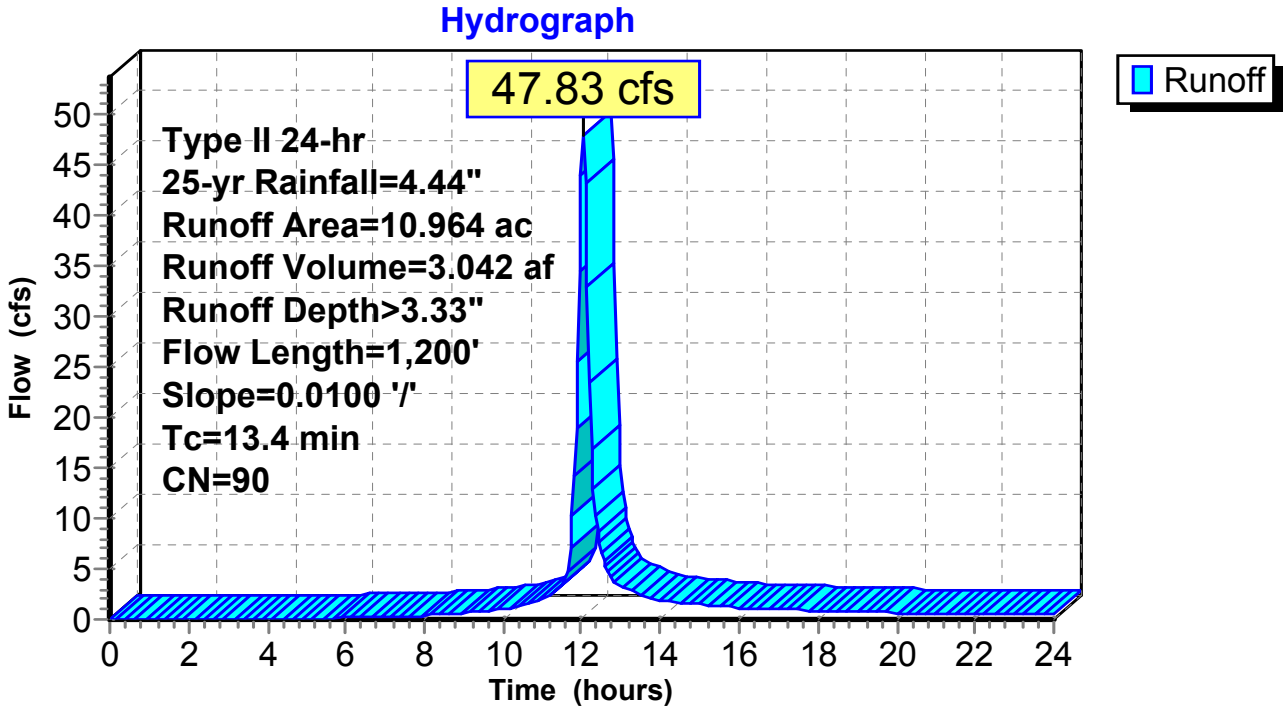
Runoff = 47.83 cfs @ 12.05 hrs, Volume= 3.042 af, Depth> 3.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.44"

	Area (ac)	CN	Description
	2.717	80	>75% Grass cover, Good, HSG D
	1.664	80	>75% Grass cover, Good, HSG D
	0.332	80	>75% Grass cover, Good, HSG D
*	6.251	98	Roof, Paved parking, HSG D
	10.964	90	Weighted Average
	4.713		42.99% Pervious Area
	6.251		57.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Pavement Catch Basin**
3.4	1,200	0.0100	5.94	10.50	**Pipe Channel, Pipe Flow** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
13.4	1,200	Total			

Subcatchment 2S: Post Development



Summary for Pond 5P: (new Pond)

Inflow Area = 10.964 ac, 57.01% Impervious, Inflow Depth > 3.33" for 25-yr event
Inflow = 47.83 cfs @ 12.05 hrs, Volume= 3.042 af
Outflow = 7.79 cfs @ 12.44 hrs, Volume= 2.533 af, Atten= 84%, Lag= 23.5 min
Primary = 7.79 cfs @ 12.44 hrs, Volume= 2.533 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 782.85' @ 12.44 hrs Surf.Area= 0.643 ac Storage= 1.544 af

Plug-Flow detention time= 163.9 min calculated for 2.528 af (83% of inflow)
Center-of-Mass det. time= 93.2 min (890.0 - 796.8)

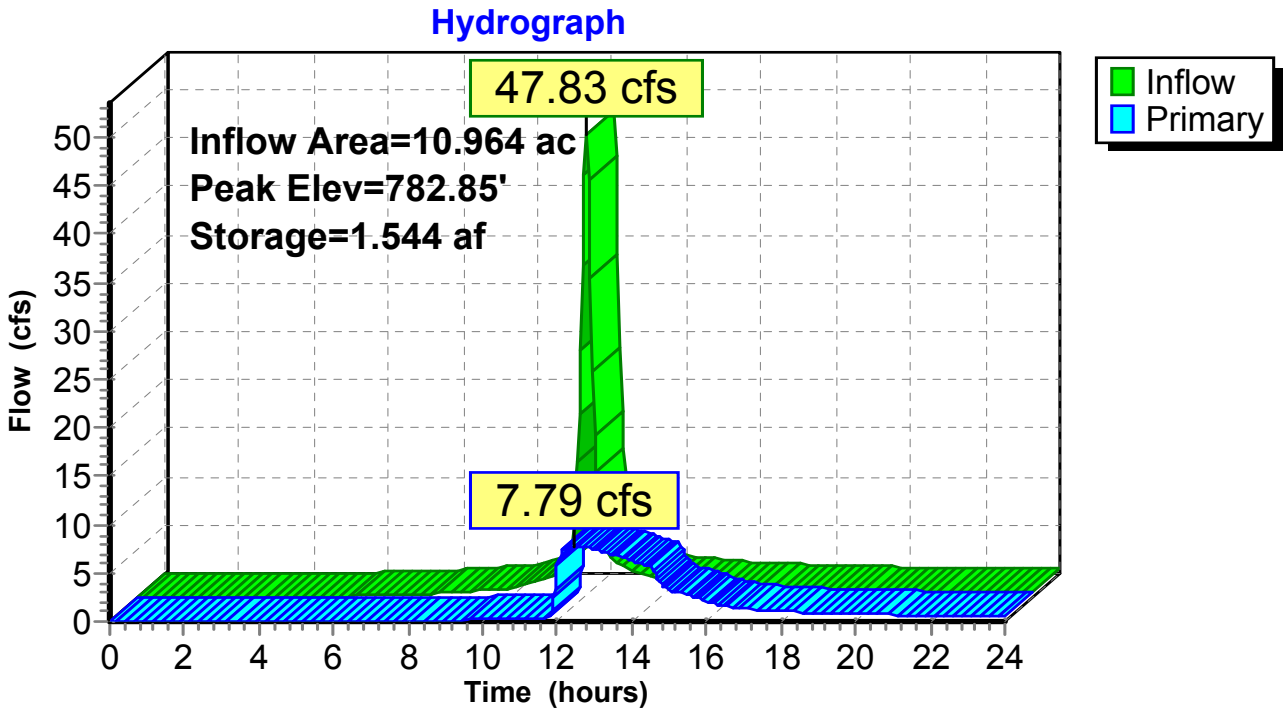
Volume	Invert	Avail.Storage	Storage Description
#1	780.00'	2.333 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
780.00	0.443	0.000	0.000
781.00	0.511	0.477	0.477
782.00	0.582	0.546	1.024
783.00	0.654	0.618	1.641
784.00	0.729	0.692	2.333

Device	Routing	Invert	Outlet Devices
#1	Primary	780.00'	**15.0" Round Culvert** L= 100.0' Ke= 0.500 Inlet / Outlet Invert= 780.00' / 779.20' S= 0.0080 '/' Cc= 0.900 n= 0.013, Flow Area= 1.23 sf
#2	Device 1	780.00'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	781.00'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 1	781.50'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=7.79 cfs @ 12.44 hrs HW=782.85' (Free Discharge)
└**1=Culvert** (Barrel Controls 7.79 cfs @ 6.35 fps)
- **2=Orifice/Grate** (Passes < 0.69 cfs potential flow)
- **3=Orifice/Grate** (Passes < 5.14 cfs potential flow)
- **4=Orifice/Grate** (Passes < 22.37 cfs potential flow)

Pond 5P: (new Pond)



Summary for Subcatchment 2S: Post Development

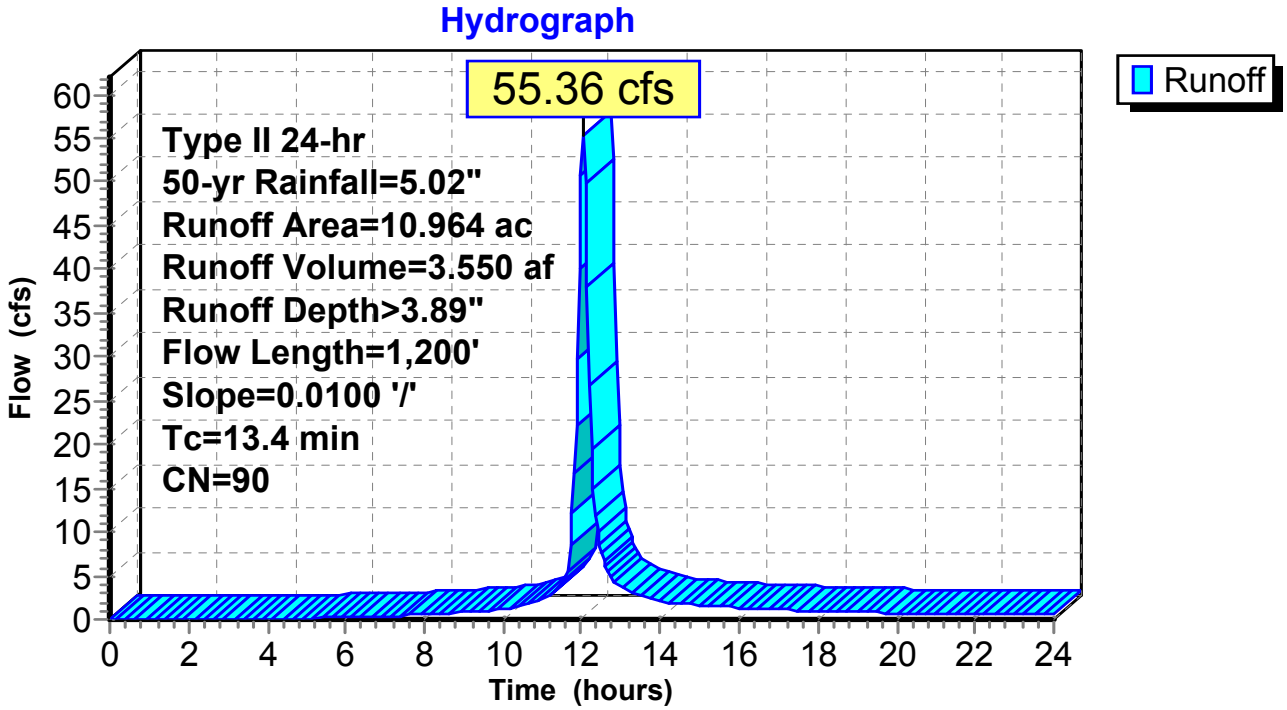
Runoff = 55.36 cfs @ 12.05 hrs, Volume= 3.550 af, Depth> 3.89"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-yr Rainfall=5.02"

	Area (ac)	CN	Description
	2.717	80	>75% Grass cover, Good, HSG D
	1.664	80	>75% Grass cover, Good, HSG D
	0.332	80	>75% Grass cover, Good, HSG D
*	6.251	98	Roof, Paved parking, HSG D
	10.964	90	Weighted Average
	4.713		42.99% Pervious Area
	6.251		57.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Pavement Catch Basin**
3.4	1,200	0.0100	5.94	10.50	**Pipe Channel, Pipe Flow** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
13.4	1,200	Total			

Subcatchment 2S: Post Development



Summary for Pond 5P: (new Pond)

Inflow Area = 10.964 ac, 57.01% Impervious, Inflow Depth > 3.89" for 50-yr event
Inflow = 55.36 cfs @ 12.05 hrs, Volume= 3.550 af
Outflow = 8.45 cfs @ 12.46 hrs, Volume= 3.032 af, Atten= 85%, Lag= 24.8 min
Primary = 8.45 cfs @ 12.46 hrs, Volume= 3.032 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 783.27' @ 12.46 hrs Surf.Area= 0.674 ac Storage= 1.820 af

Plug-Flow detention time= 164.4 min calculated for 3.032 af (85% of inflow)
Center-of-Mass det. time= 98.9 min (891.5 - 792.6)

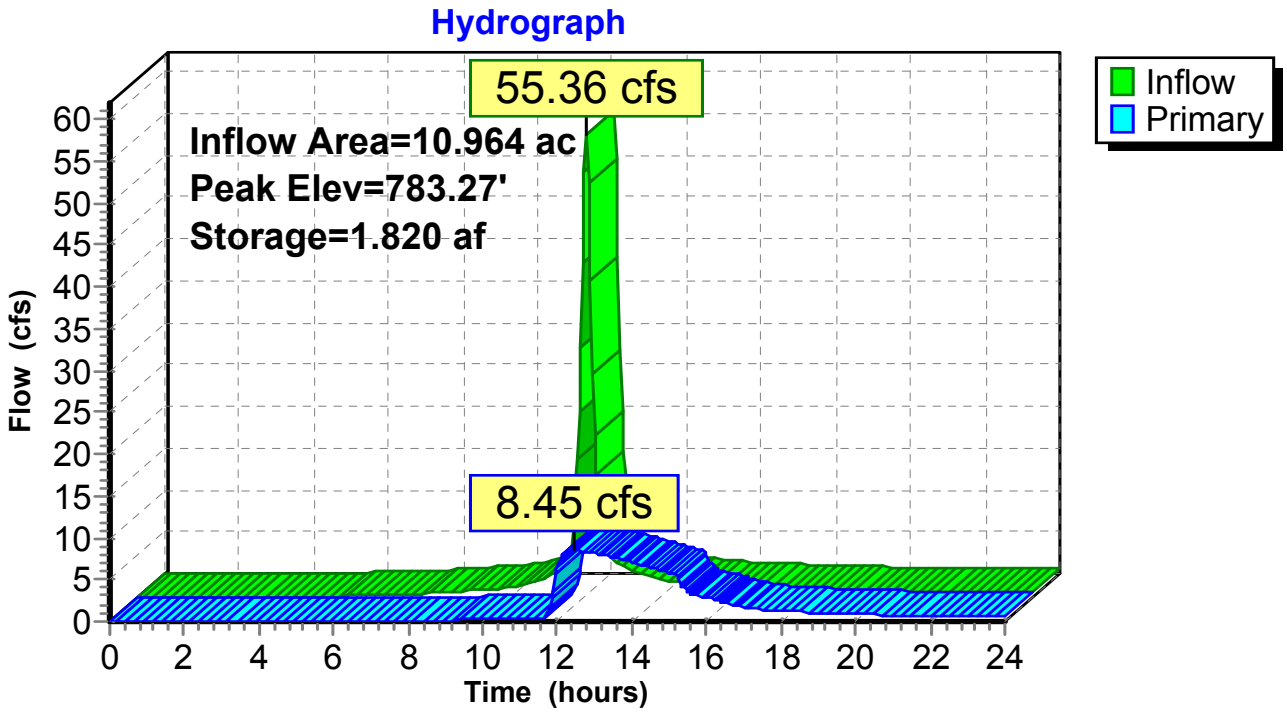
Volume	Invert	Avail.Storage	Storage Description
#1	780.00'	2.333 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
780.00	0.443	0.000	0.000
781.00	0.511	0.477	0.477
782.00	0.582	0.546	1.024
783.00	0.654	0.618	1.641
784.00	0.729	0.692	2.333

Device	Routing	Invert	Outlet Devices
#1	Primary	780.00'	**15.0" Round Culvert** L= 100.0' Ke= 0.500 Inlet / Outlet Invert= 780.00' / 779.20' S= 0.0080 '/' Cc= 0.900 n= 0.013, Flow Area= 1.23 sf
#2	Device 1	780.00'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	781.00'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 1	781.50'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=8.44 cfs @ 12.46 hrs HW=783.27' (Free Discharge)
└**1=Culvert** (Barrel Controls 8.44 cfs @ 6.88 fps)
- **2=Orifice/Grate** (Passes < 0.74 cfs potential flow)
- **3=Orifice/Grate** (Passes < 5.69 cfs potential flow)
- **4=Orifice/Grate** (Passes < 25.60 cfs potential flow)

Pond 5P: (new Pond)



Summary for Subcatchment 2S: Post Development

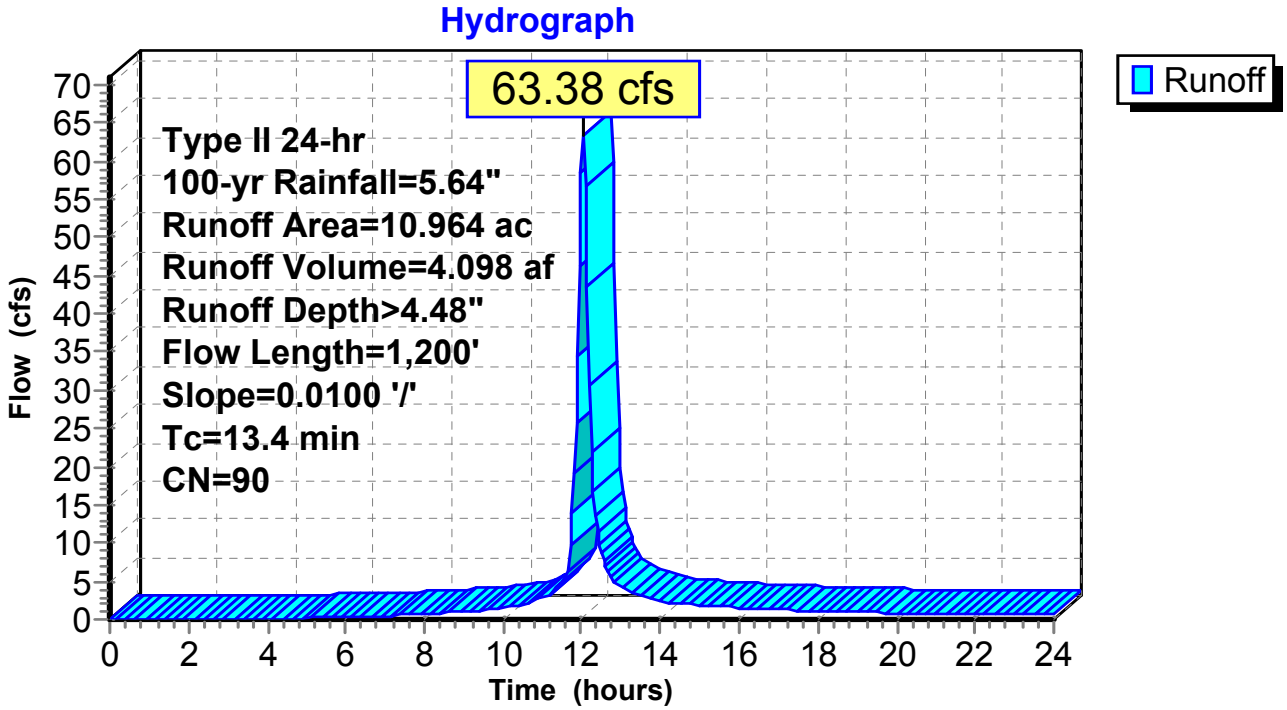
Runoff = 63.38 cfs @ 12.05 hrs, Volume= 4.098 af, Depth> 4.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=5.64"

	Area (ac)	CN	Description
	2.717	80	>75% Grass cover, Good, HSG D
	1.664	80	>75% Grass cover, Good, HSG D
	0.332	80	>75% Grass cover, Good, HSG D
*	6.251	98	Roof, Paved parking, HSG D
	10.964	90	Weighted Average
	4.713		42.99% Pervious Area
	6.251		57.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Pavement Catch Basin**
3.4	1,200	0.0100	5.94	10.50	**Pipe Channel, Pipe Flow** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013
13.4	1,200	Total			

Subcatchment 2S: Post Development



Summary for Pond 5P: (new Pond)

Inflow Area = 10.964 ac, 57.01% Impervious, Inflow Depth > 4.48" for 100-yr event
Inflow = 63.38 cfs @ 12.05 hrs, Volume= 4.098 af
Outflow = 9.06 cfs @ 12.48 hrs, Volume= 3.571 af, Atten= 86%, Lag= 26.1 min
Primary = 9.06 cfs @ 12.48 hrs, Volume= 3.571 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 783.69' @ 12.48 hrs Surf.Area= 0.706 ac Storage= 2.113 af

Plug-Flow detention time= 166.0 min calculated for 3.571 af (87% of inflow)
Center-of-Mass det. time= 105.8 min (894.5 - 788.7)

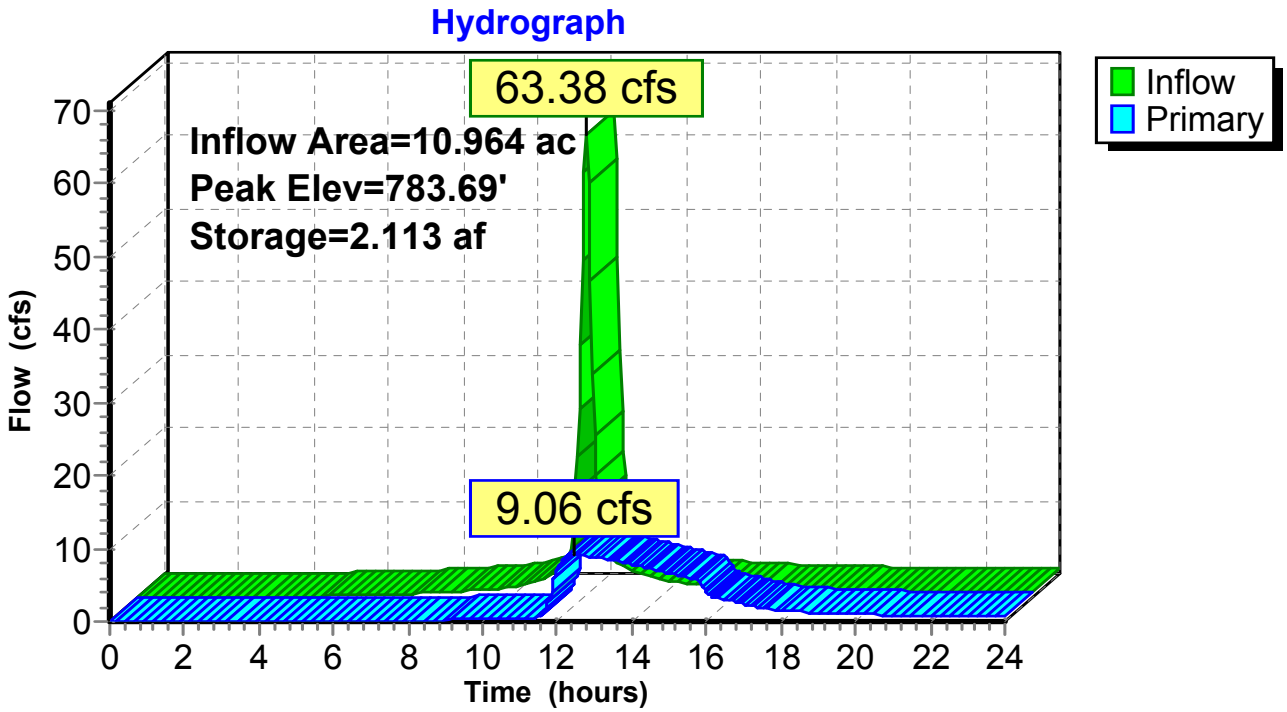
Volume	Invert	Avail.Storage	Storage Description
#1	780.00'	2.333 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
780.00	0.443	0.000	0.000
781.00	0.511	0.477	0.477
782.00	0.582	0.546	1.024
783.00	0.654	0.618	1.641
784.00	0.729	0.692	2.333

Device	Routing	Invert	Outlet Devices
#1	Primary	780.00'	**15.0" Round Culvert** L= 100.0' Ke= 0.500 Inlet / Outlet Invert= 780.00' / 779.20' S= 0.0080 '/' Cc= 0.900 n= 0.013, Flow Area= 1.23 sf
#2	Device 1	780.00'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	781.00'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 1	781.50'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=9.06 cfs @ 12.48 hrs HW=783.69' (Free Discharge)
└─**1=Culvert** (Barrel Controls 9.06 cfs @ 7.38 fps)
  ├─**2=Orifice/Grate** (Passes < 0.79 cfs potential flow)
  ├─**3=Orifice/Grate** (Passes < 6.20 cfs potential flow)
  └─**4=Orifice/Grate** (Passes < 28.52 cfs potential flow)

Pond 5P: (new Pond)



Appendix I – Post-Developed Water Quality Calculations

WATER QUALITY VOLUME CALCULATIONS

Project:	**Columbus JACK**
Job #:	**2016.02315**
Location:	**Grove City, OH**
Date	11/1/16

AMERICAN STRUCTUREPOINT INC.

Calc By: mjs

Chk By: mjs

Wet Basin

Onsite: Subarea A		
Area	10.964	acres
C Value	0.80	
WQ_V	0.548	acre-ft

Onsite: Subarea B		
Area	0.000	acres
C Value	0.40	
WQ_V	0.000	acre-ft

Offsite:		
Area	0.000	acres
C Value	0.40	
WQ_V	0.000	acre-ft

Total WQ_V	0.548	acre-ft
Total 75% WQv	0.411	acre-ft
WQ_V Elevation	780.87	

Ohio EPA WQ Formula

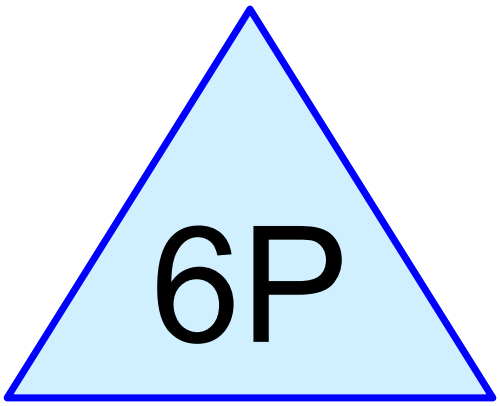
$WQ_V = CPA/12$

$C = 0.858i^3 - 0.780i^2 + 0.774i + 0.04$

i = fraction of impervious surface

P = 0.75" precipitation depth

A = drainage area in acres



WQ

Subcat Reach Pond Link

Routing Diagram for 2016.02315.CE.Detention
Prepared by American Structurepoint, Printed 11/4/2016

Summary for Pond 6P: WQ

Inflow	=	0.00 cfs @	0.00 hrs,	Volume=	0.000 af
Outflow	=	0.35 cfs @	0.00 hrs,	Volume=	0.352 af, Atten= 0%, Lag= 0.0 min
Primary	=	0.35 cfs @	0.00 hrs,	Volume=	0.352 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Starting Elev= 780.87' Surf.Area= 0.502 ac Storage= 0.411 af
Peak Elev= 780.87' @ 0.00 hrs Surf.Area= 0.502 ac Storage= 0.411 af

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no inflow)

Volume	Invert	Avail.Storage	Storage Description
#1	780.00'	2.333 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

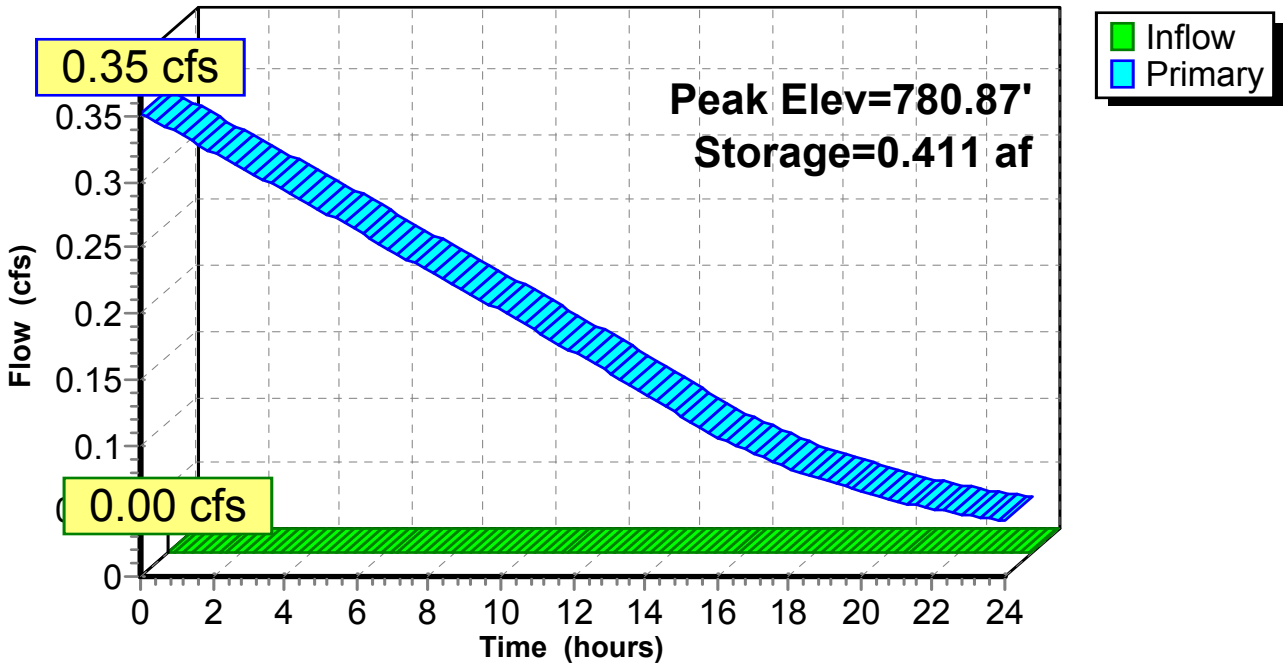
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
780.00	0.443	0.000	0.000
781.00	0.511	0.477	0.477
782.00	0.582	0.546	1.024
783.00	0.654	0.618	1.641
784.00	0.729	0.692	2.333

Device	Routing	Invert	Outlet Devices
#1	Primary	780.00'	**15.0" Round Culvert** L= 100.0' Ke= 0.500 Inlet / Outlet Invert= 780.00' / 779.20' S= 0.0080 '/' Cc= 0.900 n= 0.013, Flow Area= 1.23 sf
#2	Device 1	780.00'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	781.00'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 1	781.50'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.35 cfs @ 0.00 hrs HW=780.87' (Free Discharge)
└─**1=Culvert** (Passes 0.35 cfs of 2.71 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.35 cfs @ 4.04 fps)
  ├─**3=Orifice/Grate** (Controls 0.00 cfs)
  └─**4=Orifice/Grate** (Controls 0.00 cfs)

Pond 6P: WQ

Hydrograph



Hydrograph for Pond 6P: WQ

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Primary (cfs)
0.00	**0.00**	**0.411**	**780.87**	**0.35**
0.50	0.00	0.397	780.84	0.35
1.00	0.00	0.383	780.81	0.34
1.50	0.00	0.369	780.79	0.33
2.00	0.00	0.355	780.76	0.32
2.50	0.00	0.342	780.73	0.32
3.00	0.00	0.329	780.71	0.31
3.50	0.00	0.317	780.68	0.30
4.00	0.00	0.304	780.65	0.29
4.50	0.00	0.292	780.63	0.29
5.00	0.00	0.281	780.61	0.28
5.50	0.00	0.269	780.58	0.27
6.00	0.00	0.258	780.56	0.26
6.50	0.00	0.248	780.54	0.26
7.00	0.00	0.237	780.52	0.25
7.50	0.00	0.227	780.49	0.24
8.00	0.00	0.217	780.47	0.23
8.50	0.00	0.208	780.45	0.22
9.00	0.00	0.199	780.43	0.22
9.50	0.00	0.190	780.42	0.21
10.00	0.00	0.182	780.40	0.20
10.50	0.00	0.173	780.38	0.19
11.00	0.00	0.166	780.36	0.19
11.50	0.00	0.158	780.35	0.18
12.00	0.00	0.151	780.33	0.17
12.50	0.00	0.144	780.32	0.16
13.00	0.00	0.137	780.30	0.16
13.50	0.00	0.131	780.29	0.15
14.00	0.00	0.125	780.28	0.14
14.50	0.00	0.120	780.26	0.13
15.00	0.00	0.114	780.25	0.12
15.50	0.00	0.109	780.24	0.11
16.00	0.00	0.105	780.23	0.11
16.50	0.00	0.101	780.22	0.10
17.00	0.00	0.097	780.21	0.09
17.50	0.00	0.093	780.21	0.09
18.00	0.00	0.089	780.20	0.08
18.50	0.00	0.086	780.19	0.08
19.00	0.00	0.083	780.18	0.07
19.50	0.00	0.080	780.18	0.07
20.00	0.00	0.077	780.17	0.06
20.50	0.00	0.075	780.17	0.06
21.00	0.00	0.072	780.16	0.06
21.50	0.00	0.070	780.16	0.05
22.00	0.00	0.068	780.15	0.05
22.50	0.00	0.066	780.15	0.05
23.00	0.00	0.064	780.14	0.05
23.50	0.00	0.062	780.14	0.04
24.00	0.00	0.060	780.13	0.04

Appendix I – Storm Sewer Calculations